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ABSTRACT

Each unit in this curriculum guide on stamping die making contains an introduction, objectives, materials required, lessons, space for notes, figures, and diagrams. There are 29 units in this guide, dealing with the following topics: EZ-MILL programming; EZ-MILL BATT; print of punch and EZ-MILL part programming; download to Computer Numerical Control Bridgeport Mill; set tool length offsets; edge finding; test run; run program; pocket milling; translation, y-symmetry, rotation, scaling; EZ-Electrical Discharge Machining (EDM) programming; EZ-EDM BATT programming; wire EDM; wire-cut EDM; spark information and cutting charts; squaring the wire; set up and start point location; the main menu; principles of wire-cut EDM; Mitsubishi Medi-Apt programming; CRT settings and display unit configuration of Mitsubishi wire EDM; setup and the wire EDM; Media-Apt computer program development; program methods of describing lines off of circles and points; manual programming of piecepart; setting up and using wire EDM tools and fixtures; wire EDM setting up and taper angle cutting; sample progressive die; and Medi-Apt computer commands. Twenty-one appendixes give further information, help, and answer keys. (NLA)

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ED339884

STAMPING DIE MAKING

439-318/320

By: P. Yunke, J. Miller, R. Boyle,
D. Marlow, R. Hartzheim

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EZ-MILL PROGRAMMING

Introduction:

A. Disk Care

1. Do not touch disk surface
2. Do not bend or distort
3. Keep clean
4. Use felt-tip pen for labeling
5. Keep away from magnetic sources
6. Store disk vertically

B. Routine Care

1. Make sure area is clean
2. Beverages and food are not allowed near computers
3. If you plan to leave the system on for long periods of time, remember to turn the screen brightness down or it could damage the screen
4. Do not drop the mouse or let it hang from its cable
5. Use the mouse on a clean, dust-free surface

C. Hardware Start-Up

1. Turn on computer terminal at right rear on cabinet.
2. Turn on all peripheral equipment.
3. Reverse procedure for shut down.

Objectives:

Upon successful completion of this unit, the student will:

1. Be familiar with disks
2. Be familiar with hardware start-up
3. Have an awareness of proper hardware and software care.

Materials Required For EZ-MILL Programming

1. Either a 3 1/2" or 5 1/4" disk. It must be double-sided, high-density.
2. Access to an IBM Compatable computer with EZ-CAM software loaded.
3. EZ-MILL User's Manual

Start Up Procedure For EZ-MILL

Turn on the main electrical switch, , which will usually activate the monitor, keyboard, computer, and printer. If the monitor doesn't light up, press the switch on the monitor. Make sure the keyboard is on by pressing

NUM
LOCK .

The key will light up and the "upper case numbers" under the key will be available for programming, providing the keyboard is on. The computer has a switch on the back that can be used if the green light doesn't show at the front. You can also hear the computer run if it is on. The printer will light up if it is on. If it isn't, use the switch on the side of the printer. The

on line	off line

button will enable you to print information by pressing it until the light next to "on line" shows. If the light is off, you will be able to move the paper one line at a time with the

Draft AutoLoad	Line Feed

button.

You can move the paper one sheet at a time by pressing the

NLQ ROMAN SANS SERIF	FORM FEED

button.

You can also roll the paper by hand with the hand roller located on the right side of the printer (only when the printer is turned off). Position the paper perforation slightly above the feed sprockets.

To Format A Disk

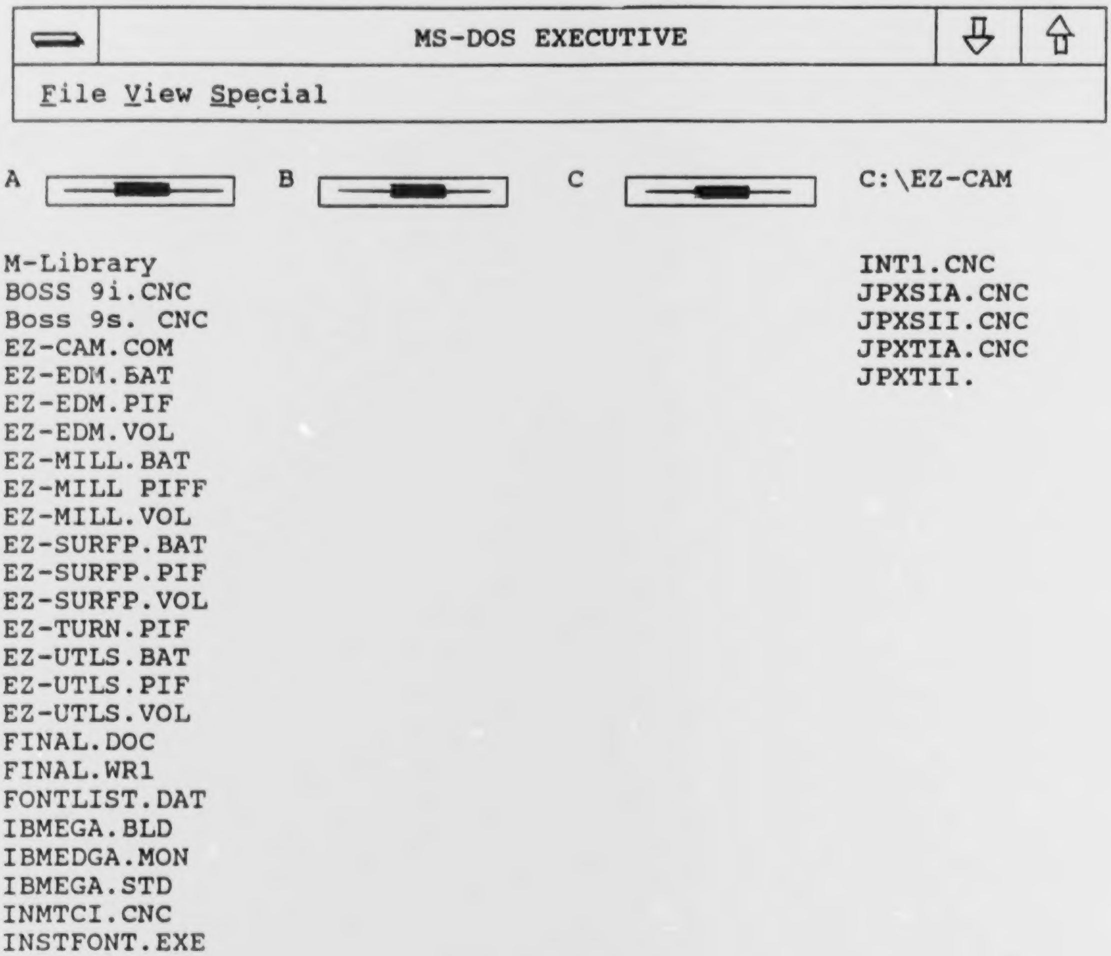
Introduction:

The disk must be formatted in order to accept (store or save) programmed information. During the formatting, the disk is divided into approximately 80 multiple segments.

Objectives:

1. Upon successful completion of this unit, the student will be able to format a disk.
2. The student will understand what happened to the disk during formatting.

A menu of the hard drive (C) will appear as below. The total software loaded in the C drive can vary from that pictured below.

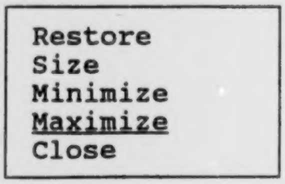

MS-DOS EXECUTIVE
File View Special
A
B
C

C:\EZ-CAM

M-Library
BOSS 9i.CNC
Boss 9s. CNC
EZ-CAM.COM
EZ-EDM.BAT
EZ-EDM.PIF
EZ-EDM.VOL
EZ-MILL.BAT
EZ-MILL PIFF
EZ-MILL.VOL
EZ-SURFP.BAT
EZ-SURFP.PIF
EZ-SURFP.VOL
EZ-TURN.PIF
EZ-UTLS.BAT
EZ-UTLS.PIF
EZ-UTLS.VOL
FINAL.DOC
FINAL.WR1
FONTLIST.DAT
IBMEGA.BLD
IBMEDGA.MON
IBMEGA.STD
INMTCI.CNC
INSTFONT.EXE

INT1.CNC
JPXSIA.CNC
JPXSII.CNC
JPXTIA.CNC
JPXTII.

To Format: If the "MS DOS Executive" picture (shown above) comes up and we haven't formatted a disk, click on the upper left corner " ▭ " and a small blue box will appear at the upper left. Click on "close."

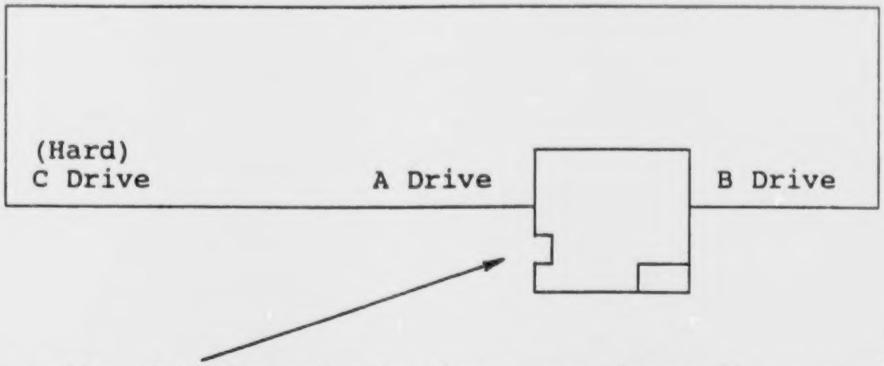

Restore
Size
Minimize
Maximize
Close

"End Session" will come up. Click on "OK" and the "Tool and Die Software" menu will come up.

```
EZ, EZ-CAM
Tutor, Tutor - Word Perfect
WP, Word Perfect (Version 4.2)
FA, Format a blank disk in drive A: (1.2 M)
Ship, Park Hard Drive for Moving


Please select letter code and enter
```

Formatting the disk will prepare it for use with our software called "EZ-CAM".

Type F A and press ENTER RETURN . The bottom of the screen will say, "Insert new disk in drive A: and press ENTER RETURN when ready." The disk must go in as pictured.



Make sure the slot doesn't have tape over it or it won't accept a format. The slot is usually taped if it has information on it that must not be erased. Insert the disk, flip the lock lever down, and hit the key labeled,

ENTER
RETURN

You can watch the bottom of the screen while the format is happening. It will start at:

```
HEAD: 0   CYLINDER: 0
      1
```

and will end at:

```
HEAD: 0   CYLINDER: 79
      1
```

This takes approximately "79" seconds. The bottom of the screen will say, "Do you want to format another disk? (Y or N)". Type N and ENTER RETURN. The "Tool and Die Software Menu" will appear and we are now ready to enter EZ-CAM.

```
EZ, EZ-CAM
Tutor, Tutor - Word Perfect
WP, Word Perfect (Version 4.2)
FA, Format a blank disk in drive A: (1.2 M)
Ship, Park Hard Drive for Moving


Please select letter code and enter
```

Type _E Z_ and press ENTER RETURN . We are now in "windows."

The top of the screen will say, "MS DOS Executive." "Windows" is an area in the computer that will display all the software packages that are available to us. The two software packages that we will work with are called "EZ-EDM.BAT" and "EZ-MILL.BAT". You are going to mill a punch which means you will want to use the "EZ-MILL.BAT" software.

Notes:

INTRODUCTION TO EZ-MILL.BAT USING SIMPLIFIED INTERACTIVE PART PROGRAMMING

Introduction

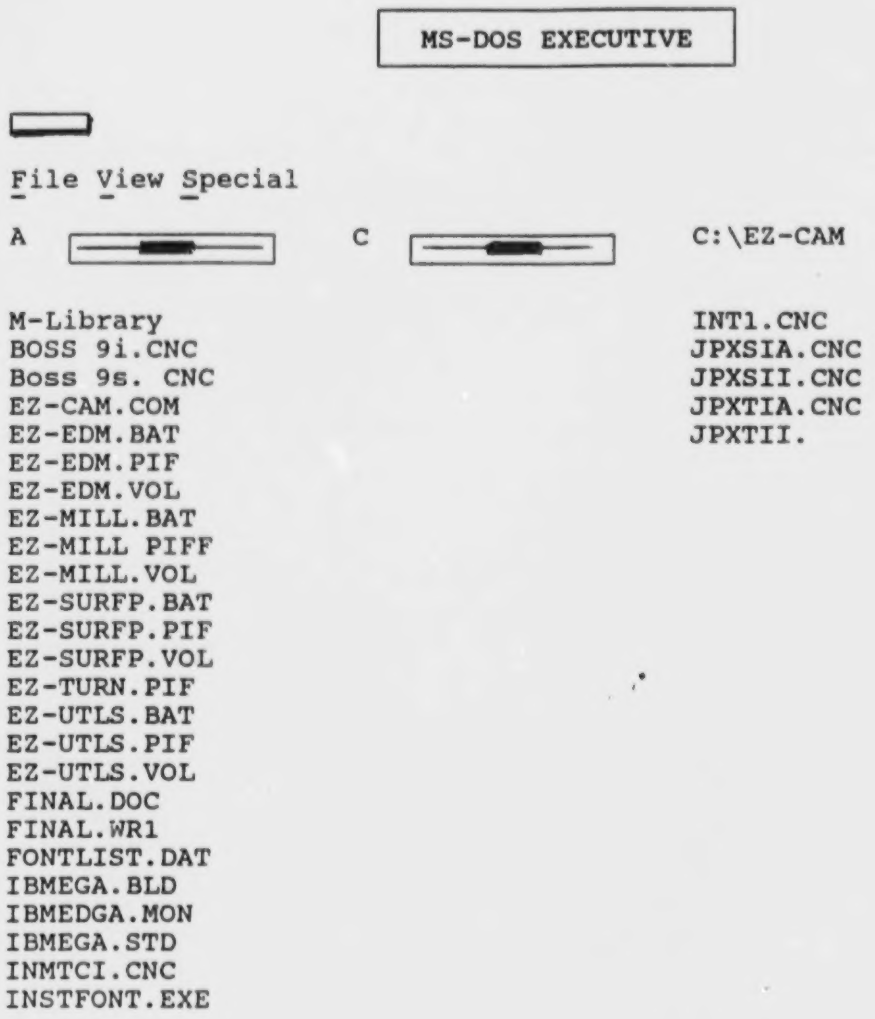
The first step to a complete understanding of EZ-MILL is to familiarize yourself with the basic setup procedure using SIPP, Setup, Set Windows, Axis, and Geometry.

In this unit, we will discuss quadrants, window size, screen layout, and line definitions.

Objectives

Upon successful completion of this unit, the student will:

1. Be able to access windows and EZ-MILL.BAT.
2. Be able to access and use Simplified Interactive Part Programming (SIPP).
3. Be able to access Setup in the top menu and Set Windows in the second level menu.
4. Be able to access the Axis command and understand the four quadrants.
5. Be knowledgeable in the ten areas used in the screen layout.
6. Be able to calculate, set, and store the new window size.
7. Be able to access geometry in the top menu.
8. Be able to define lines using parallel X and Y axis.

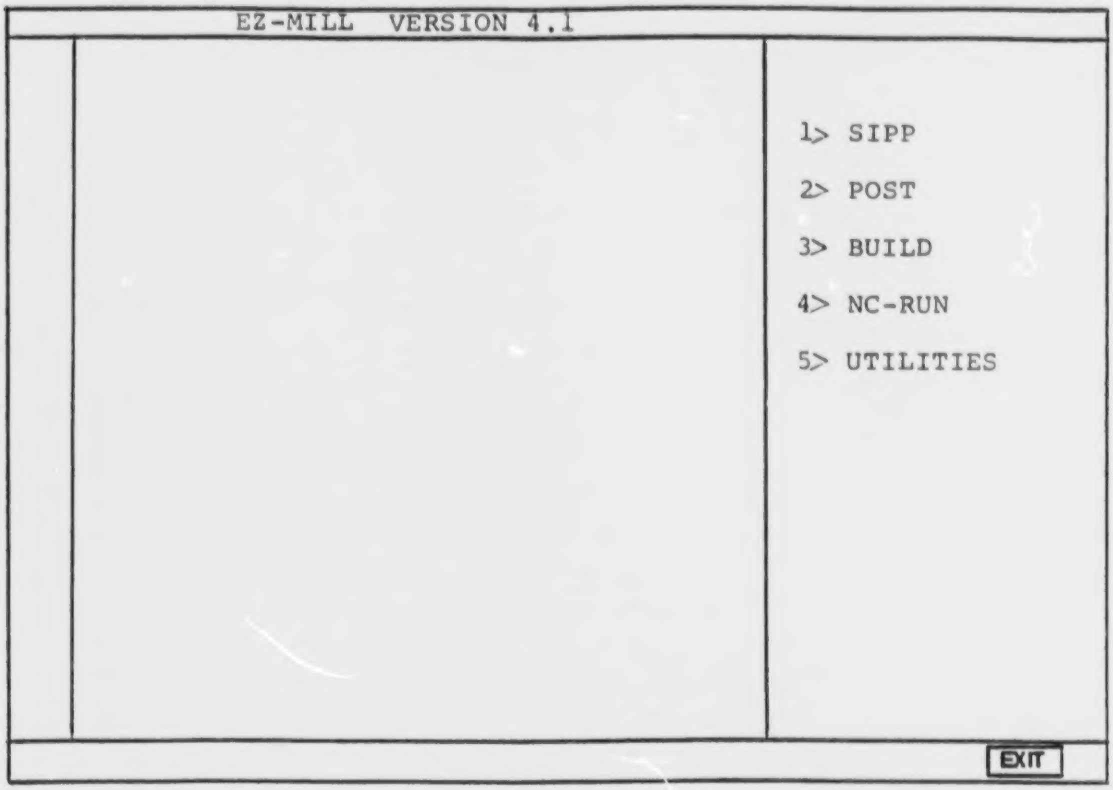


```
                    MS-DOS EXECUTIVE

File View Special

A                         C                         C:\EZ-CAM

M-Library                                           INT1.CNC
BOSS 9i.CNC                                         JPXSIA.CNC
Boss 9s. CNC                                        JPXSII.CNC
EZ-CAM.COM                                          JPXTIA.CNC
EZ-EDM.BAT                                          JPXTII.
EZ-EDM.PIF
EZ-EDM.VOL
EZ-MILL.BAT
EZ-MILL PIFF
EZ-MILL.VOL
EZ-SURFP.BAT
EZ-SURFP.PIF
EZ-SURFP.VOL
EZ-TURN.PIF
EZ-UTLS.BAT
EZ-UTLS.PIF
EZ-UTLS.VOL
FINAL.DOC
FINAL.WR1
FONTLIST.DAT
IBMEGA.BLD
IBMEDGA.MON
IBMEGA.STD
INMTCI.CNC
INSTFONT.EXE
```

Select: **EZ-MILL.BAT** with the left button of the mouse. Click twice quickly or it won't take. You can also use the arrow keys on the right of the keyboard to highlight your menu choice. This would then require your pressing the ENTER RETURN key.

A third choice would be to highlight your choice with the mouse and then press ENTER RETURN.

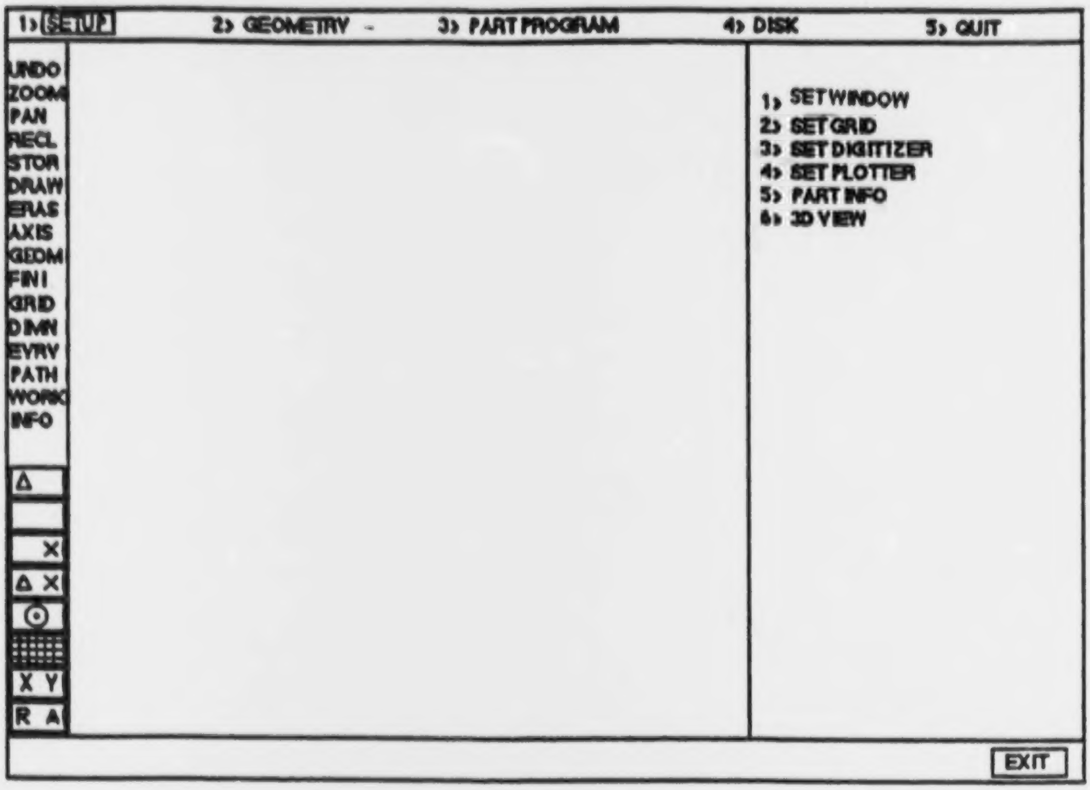
The hour glass " ⌛ " will appear if done properly. The top of the screen will change to "EZ-MILL Version 4.1". From the five choices that come up on the screen,


EZ-MILL VERSION 4.1
1> SIPP
2> POST
3> BUILD
4> NC-RUN
5> UTILITIES
EXIT

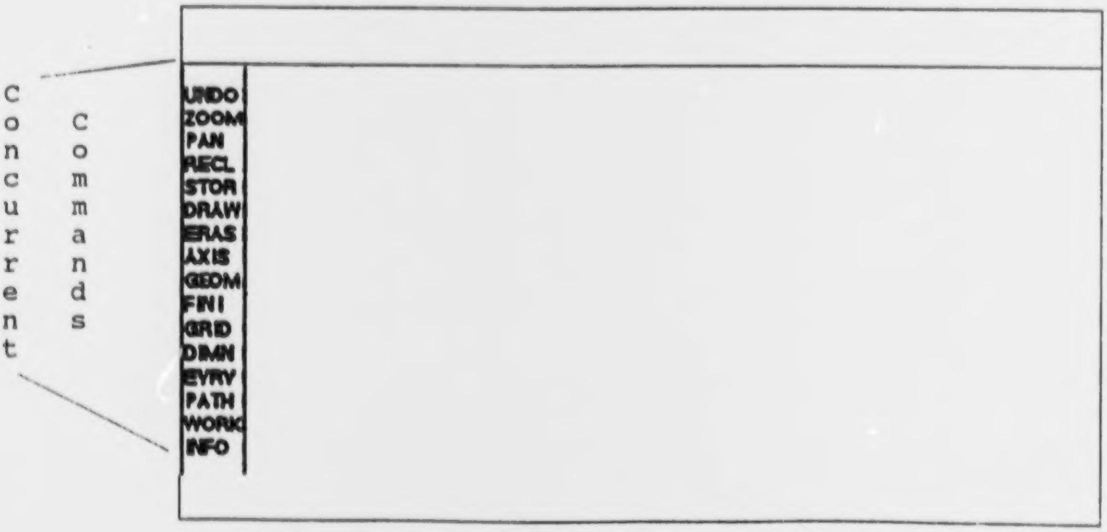
Select Number **1> SIPP**, by moving the cursor to SIPP and clicking the mouse. (SIPP is an abbreviation for Simplified Interactive Part Programming)

You can use any button on the mouse now if you want to. We only use the left button when we are "in windows." Select **1> SET UP** from the screen below. Use your mouse.

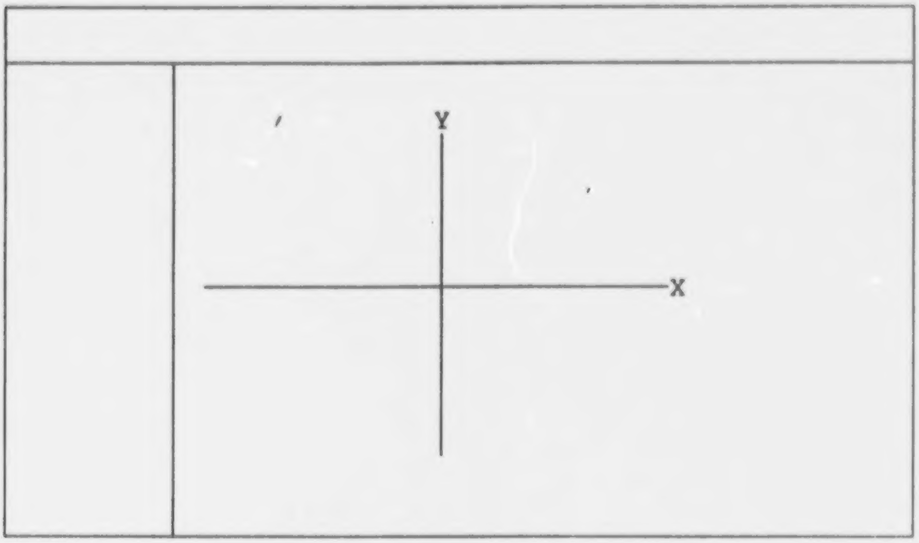
1> SET UP will get boxed in blue and the screen will appear as below.


1> SETUP
2> GEOMETRY
3> PART PROGRAM
4> DISK
5> QUIT
UNDO
ZOOM
PAN
RECL
STOR
DRAW
ERAS
AXIS
GEOM
FINI
GRID
DIMN
EVRV
PATH
WORK
INFO
Δ
X
Δ X
X Y
R A
1> SET WINDOW
2> SET GRID
3> SET DIGITIZER
4> SET PLOTTER
5> PART INFO
6> 3D VIEW
EXIT

Select: **AXIS** from the "Concurrent Commands" on the left side of the screen or press "A" on keyboard. Either method will toggle the axis on-off.


Concurrent Commands
UNDO
ZOOM
PAN
RECL
STOR
DRAW
ERAS
AXIS
GEOM
FINI
GRID
DIMN
EVRV
PATH
WORK
INFO

The axis will come up centered on the screen as shown below.



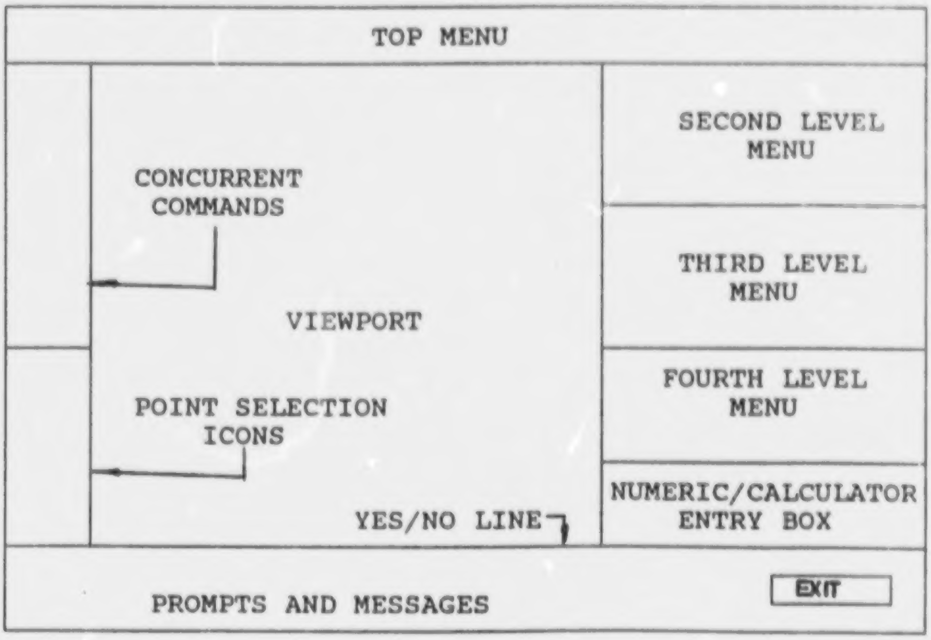
Four quadrants are shown above and we can work in all four at once or we could pick one to work in. Your part print will usually dictate how you should set the "window" which is going to be your area for the drawing, called the "geometry." Many people like to work in the upper right (first) quadrant which would make the geometry all positive from the intersection of the X and Y axis. X and Y, of course, both equal zero at this point.

If we decide to work in the upper right quadrant, let's put the X and Y axis to the bottom and left sides of our screen. This will give us a larger window to work in. This means we will be moving the axis intersection to the lower left part of the screen.

Make sure the light shows on the NUM LOCK key. If it doesn't, just press the key. Again, this will enable us to use all the number keys below the NUM LOCK key.

The number keys at the top of the key board are also available.

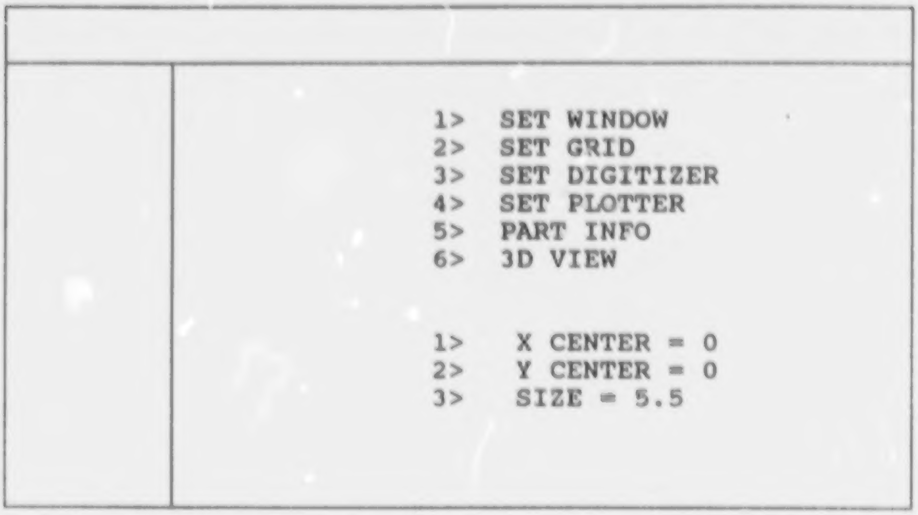
Don't forget to check all parts of your screen. The drawing below gives you the screen layout you will be working with.


TOP MENU
CONCURRENT COMMANDS
VIEWPORT
POINT SELECTION ICONS
YES/NO LINE
SECOND LEVEL MENU
THIRD LEVEL MENU
FOURTH LEVEL MENU
NUMERIC/CALCULATOR ENTRY BOX
PROMPTS AND MESSAGES
EXIT

See Chapter 3-2 in the User's Manual for more information.

Select "Set Window" with the mouse. The screen will appear as below.

Note: Use the mouse for your menu choices from now on.


1> SET WINDOW
2> SET GRID
3> SET DIGITIZER
4> SET PLOTTER
5> PART INFO
6> 3D VIEW

1> X CENTER = 0
2> Y CENTER = 0
3> SIZE = 5.5

Select: 1> **X CENTER**, it will be boxed. X Center = 0

Type: .75

Select: Enter , **1> X CENTER** = .75 appears

Select: 2> **Y CENTER**, it will be boxed. Y Center = 0

Type: .75

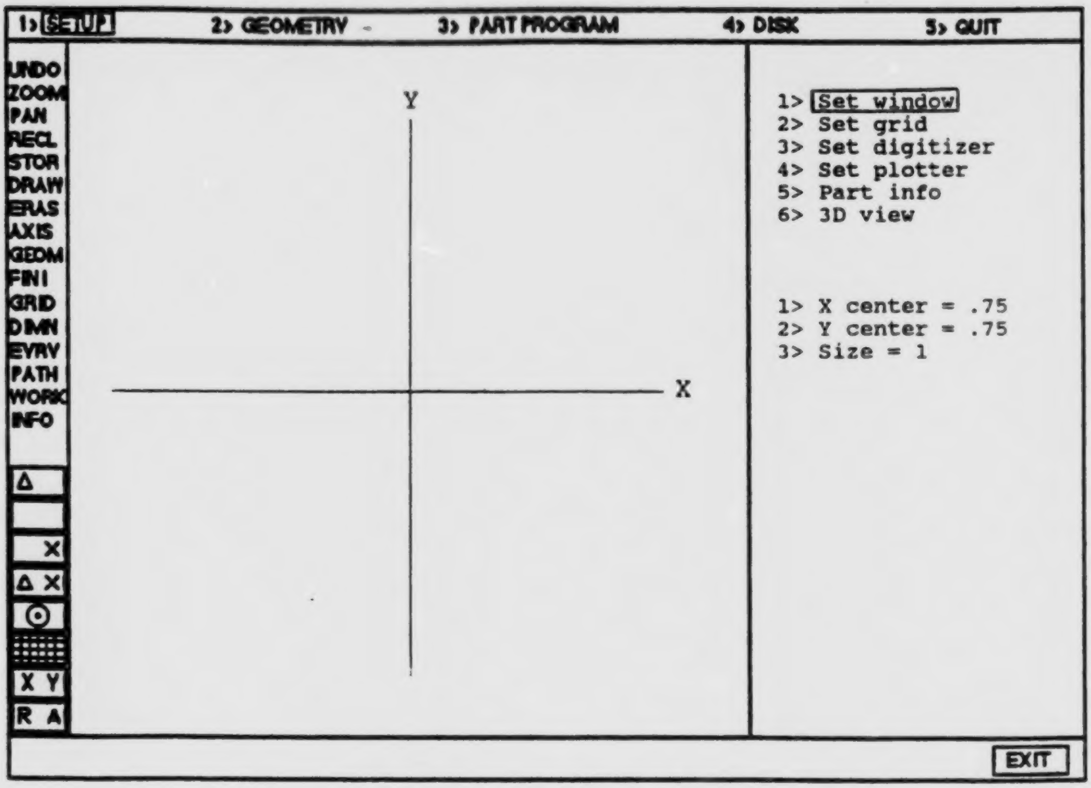
Select: Enter , **2> Y CENTER** = .75 appears

Select: 3> **SIZE**, it will be boxed. Size = 5.5

Type: 1

Select: Enter , **3> SIZE** = 1 appears

Your picture now appears as below:


1> SETUP
2> GEOMETRY
3> PART PROGRAM
4> DISK
5> QUIT
UNDO
ZOOM
PAN
RECL
STOR
DRAW
ERAS
AXIS
GEOM
FINI
GRID
DIMN
EVRY
PATH
WORK
INFO
Δ
X
Δ X
X Y
R A
Y
X
1> Set window
2> Set grid
3> Set digitizer
4> Set plotter
5> Part info
6> 3D view
EXIT

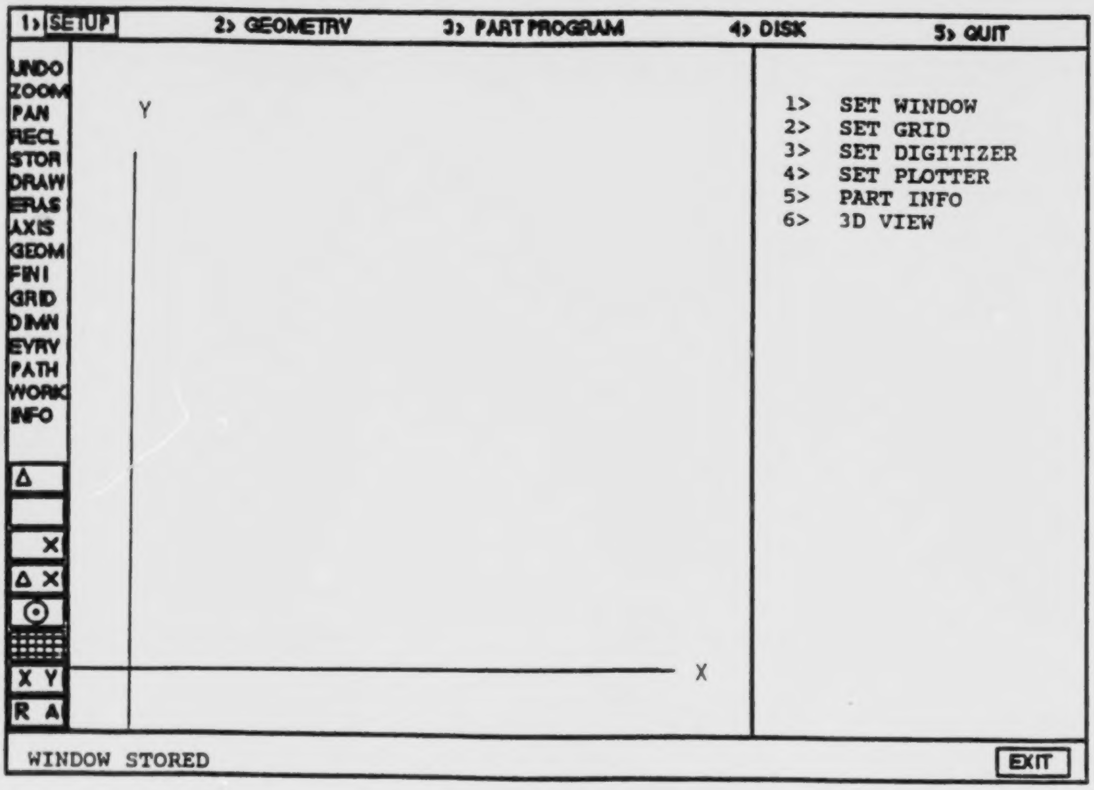
1> X center = .75
2> Y center = .75
3> Size = 1

Select: **EXIT**, lower right and the new axis will appear.

Select: **STOR**, from concurrent commands on left side of screen. "Change stored window" appears in the prompts and messages box. Click the mouse anywhere above the yes/no line, lower right $\frac{\text{Y}}{\text{N}}$. This signifies a yes.

WINDOW STORED appears at the lower left in the prompts and messages area.

Your screen will appear as below:


1> SETUP
2> GEOMETRY
3> PART PROGRAM
4> DISK
5> QUIT
UNDO
ZOOM
PAN
RECL
STOR
DRAW
ERAS
AXIS
GEOM
FINI
GRID
DIMN
EVRV
PATH
WORK
INFO
Δ
X
Δ X
X Y
R A
Y
X
1> SET WINDOW
2> SET GRID
3> SET DIGITIZER
4> SET PLOTTER
5> PART INFO
6> 3D VIEW
EXIT

WINDOW STORED

Just to prove what happens when you have set your new window size at these new values,

X Center = .75,   Y Center = .75,   Size = 1

Select: **2> GEOMETRY** from top menu

Note: Make sure, mode = define; If not select mode and nine menu items will appear in the third level menu. Select define.

Select: **3> LINE**

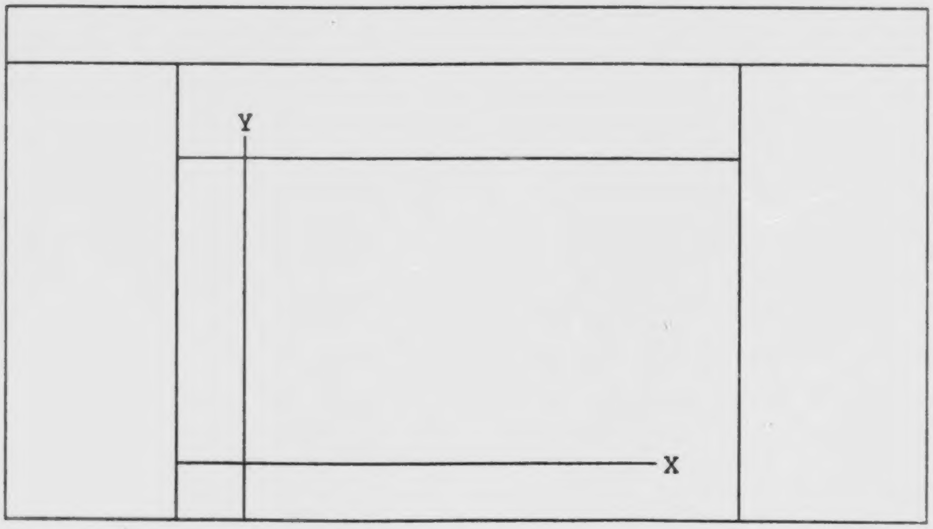
Select: **1> PARALLEL X AXIS**

Offset value <0.0> appears above the numeric/calculator entry box.

Type: 1.408

Press: ENTER RETURN , and a line appears parallel to the X axis.

See below.



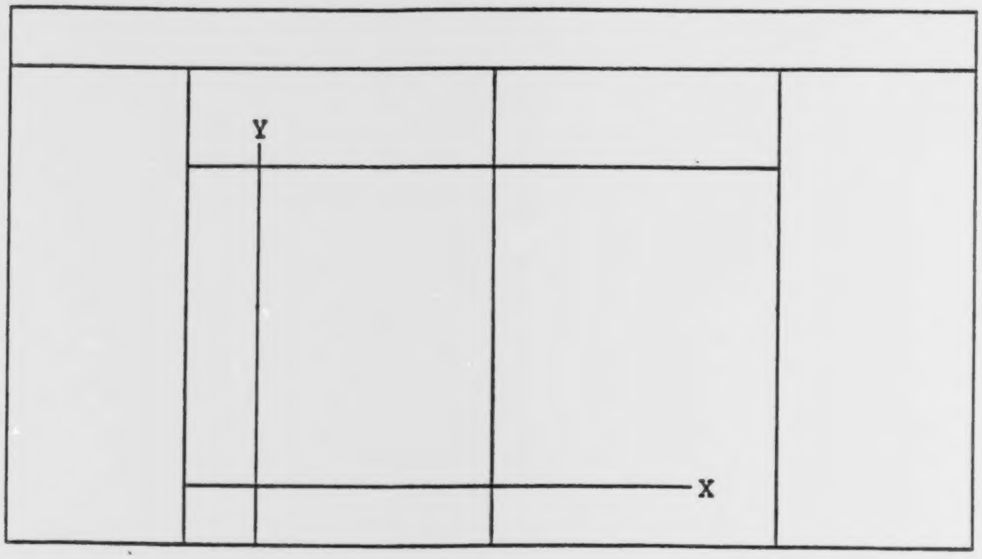
Select: **2> PARALLEL Y AXIS**

The last entry value will appear above the numeric/calculator entry box.

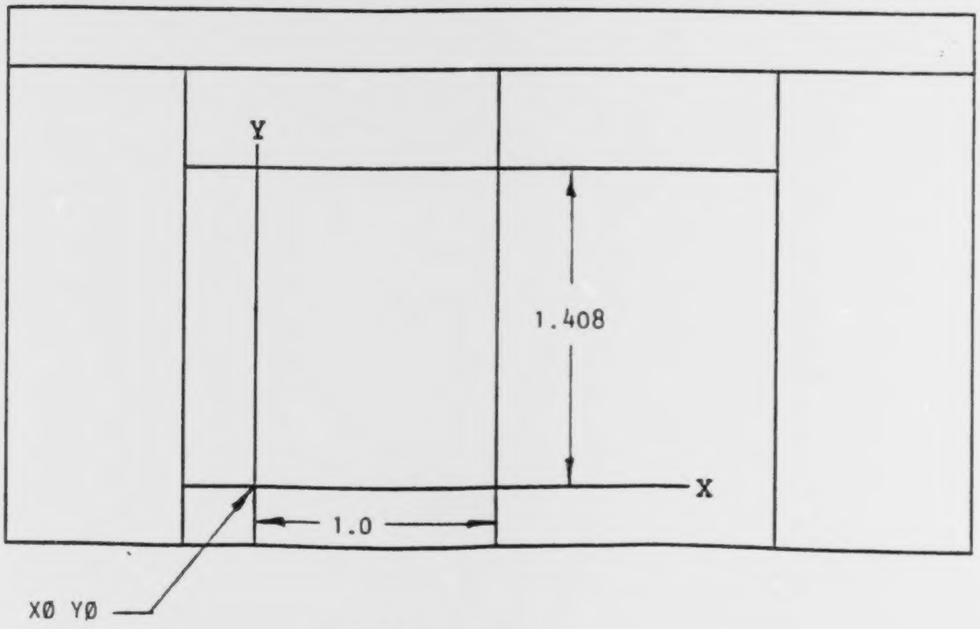
Type: 1.0

Press: **ENTER RETURN** , and a line appears parallel to the Y axis.

See below.



Note that the X=1, Y=1.408, all show up clearly as indicated on the following screen picture.



We picked 1 for the window size which means it is 1" from the center of the screen to the edge of the screen. We picked 1.408 for the horizontal line which means it is 1.408" from the X-axis. We picked 1 for the vertical line which means it is 1" from the Y-axis.

Just For Experience:

Select: 1> **SET UP** from the top menu

Select: 1> **SET WINDOW** from the second level menu

Select: 1> **X CENTER** from the third level menu

Type: 8

Press: ENTER RETURN

Select: 2> **Y CENTER** from the third level menu

Type: 8

Press: ENTER RETURN

Select: 3> **SIZE** from the third level menu

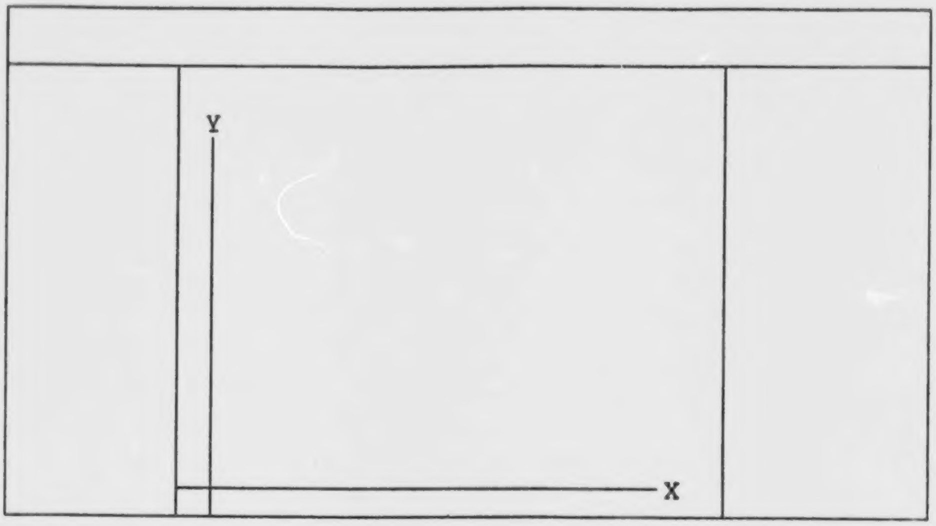
Type: 8

Press: ENTER RETURN

Note that all now equal eight.

1> X Center = 8
2> Y Center = 8
3> Size = 8

Select: **EXIT** Note new axis lines (X & Y) appear at edges of screen.



Select: **STOR** from concurrent commands if you want to save this new axis. Bottom left of screen says, "Change stored window?"

Select: **Y**, by clicking above the yes/no line.

WINDOW STORED appears at the lower left.

The axis is now 8" from the center of the screen and the window center is 8" from the side of the screen.

If at this time you want to create new geometry:

Select **5> QUIT** from the top menu

Select **1> START OVER**

Confirm by typing Y for yes

This will clear your screen and allow you to start over.

Notes:

INTRODUCTION TO PART PROGRAMMING USING SETUP/GEOMETRY/PART PROGRAM AND DISK

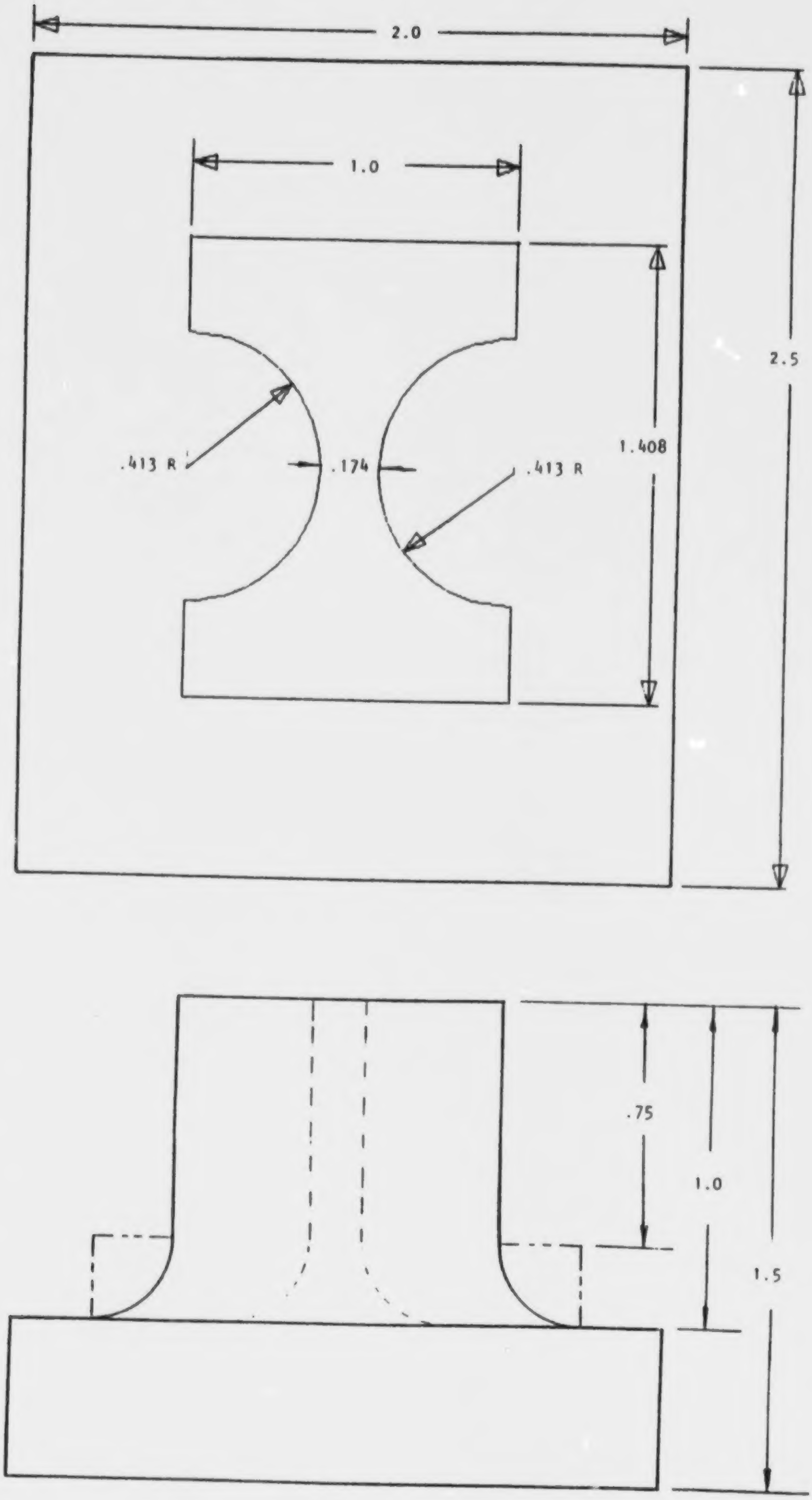
Introduction

This unit will provide the student with all the information that is required to create CNC (Computerized Numerical Control) part programs using EZ-MILL software.

Objectives

Upon successful completion of this unit, the student will:

1. Be able to understand which quadrant(s) to use when drawing the geometry.
2. Be able to recognize nine items in mode from the third level menu.
3. Be aware of the prompts and messages area on the screen layout.
4. Be able to create horizontal and vertical lines by using the parallel X and parallel Y axis.
5. Understand the use of the numeric/calculator entry box.
6. Be able to insert points and circles.
7. Understand the relationship between your disk and the various drives.
8. Understand the principles involved in saving geometry on your disk.
9. Understand the concept of using numbers when labeling various segments.
10. Be able to use the milling cycles.



2.0
1.0
2.5
1.408
.413 R
.174
.413 R
.75
1.0
1.5

EZ-MILL PART PROGRAMMING EXAMPLE

(Punch)

Select **1> SIPP**

Select **axis** from concurrent commands.

Select **1> SET UP**

Select **1> SET WINDOW**

After studying the drawing, it is more practical to do our geometry in the first quadrant with the lower left corner as our X=0 and Y=0 coordinates.

Due to the small size of the part, set the X center and Y center to 1.25 each and the size to 1.5.

Select **1> X CENTER**

Type 1.25

Press ENTER RETURN

Select **2> Y CENTER**

Type 1.25

Press ENTER RETURN

Select **3> SIZE**

Type 1.5

Press ENTER RETURN

Select **EXIT**

Select Stor from concurrent commands if you want to save this new axis.

CHANGE STORED WINDOW? appears in the prompts and messages area at the bottom left of the screen.

Select Y by clicking above the yes/no line. You could also type Y on the keyboard for yes.

WINDOW STORED appears at lower left in the prompts and messages area.

Select 2> **GEOMETRY** from top menu.

Note: *Make sure mode equals define; if not, select mode and nine menu items will appear in the third level menu. Select define.*

Select 3> **LINE**

In studying the drawing, it is apparent that the Y-axis should become the left edge of the part. Therefore, select item two in the third level menu which is **2> PARAL Y-AXIS.** The default offset value appears as <0.0> above the numeric/calculator entry box.

Click the mouse and the line will appear on the Y-axis. You could also type 0.

Press ENTER RETURN

Note: *Your last geometry can be undone by immediately selecting Undo from the concurrent commands.*

Select 1> **PARALLEL X AXIS**

Type zero (0)

Press ENTER RETURN

While still in parallel X axis, type 2.5.

Press ENTER RETURN or click mouse.

Note: *When clicking mouse, make sure the cursor is in the viewport area.*

This will define the top edge of the part.

Select **2> PARAL Y AXIS** in order to establish the right edge of the part.

Type 2.0 and it will appear in the numeric/calculator entry box.

Press ENTER RETURN or click mouse.

Note: When clicking mouse, make sure the cursor is in the viewport area.

The part perimeter has now been established. You will now draw the geometry for the punch. **3> LINE** had been selected and therefore you can now draw the horizontal and vertical lines for the punch which is located in the center of the 2" x 2 1/2" tool steel block.

Type .5

Press ENTER RETURN

Type 1.5

Press ENTER RETURN

The two vertical sides of the punch have now been established.

Select **1> PARAL X AXIS**

Type .546 (This is the offset value from the X axis which is the bottom edge of the punch).

Press ENTER RETURN

Type 1.954

Press ENTER RETURN

You have now completed all the lines necessary.

Important: DO NOT exit SIPP until you have saved your work. If you exit SIPP prior to saving, your work will be lost.

Select **2> POINT** from second level menu

Select **1> XY COORD**

At this time you will insert points for circle centers. Check your print for the location of these points from the X=0, Y=0 location.

Type .5 for the X value.

Press ENTER RETURN

Type 1.25 for the Y value.

Press ENTER RETURN, (your first point now appears)

Type 1.5 for the X value.

Press ENTER RETURN

Press ENTER RETURN without putting in a Y value because it is the same as the previous Y value (1.25).

(your second point now appears)

Select **4> CIRCLE** from the second level menu

Select **1> CENTER POINT** from the third level menu

Type .413 (which is our circle radius)

Press ENTER RETURN

Note: *The point icon* [△] *is now active at the left side of your screen.*

The prompt and message area now states, PICK POINT WITH CURSOR.

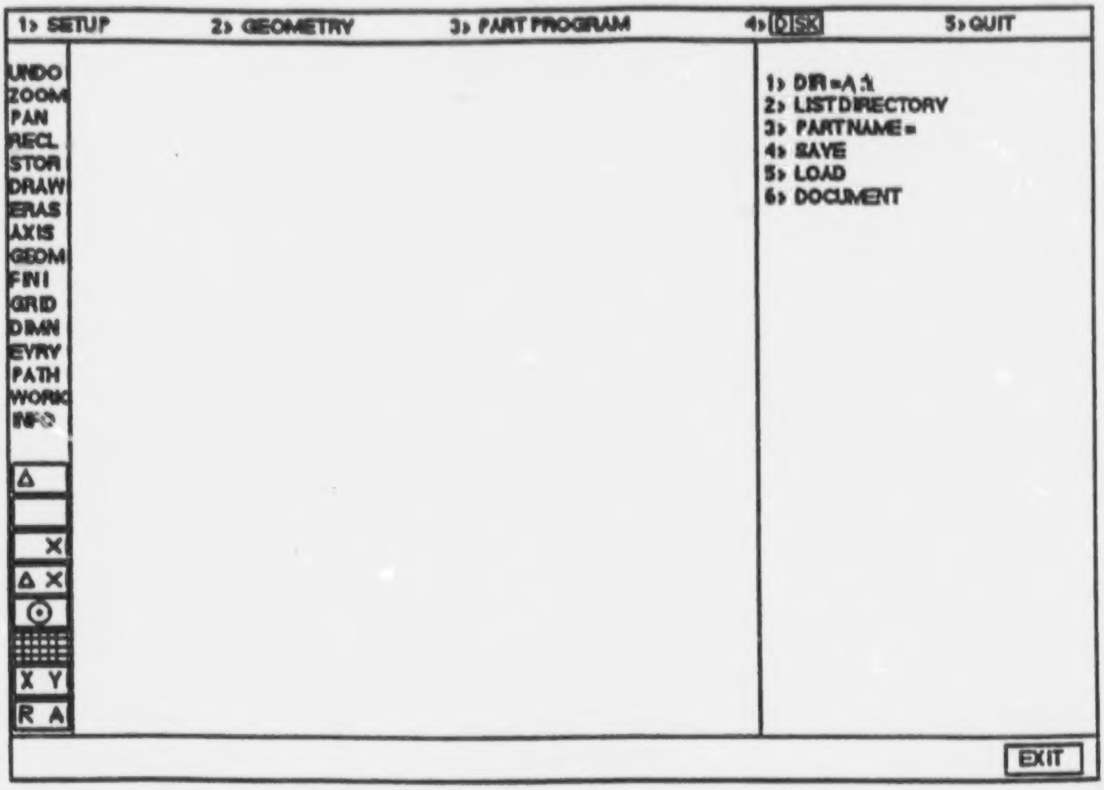
Click mouse on or near the center points. This may require more than one click.

Note: *The radius value can be changed at any time.*

After completing your geometry, the accepted practice is to save your work on your disk (A: or B: drive).

Select **4> DISK** from the top menu.

To save geometry:


1> SETUP
2> GEOMETRY
3> PART PROGRAM
4> DISK
5> QUIT
UNDO
ZOOM
PAN
RECL
STOR
DRAW
ERAS
AXIS
GEOM
FINI
GRID
DIMN
EVRY
PATH
WORK
INFO
△
×
△ ×
⊙
X Y
R A
1> DIR = A:\
2> LIST DIRECTORY
3> PARTNAME =
4> SAVE
5> LOAD
6> DOCUMENT
EXIT

Check second level menu for **1> DIR**. It should read A:\ or B:\ depending which drive you are working in. If it doesn't, select **1> DIR.**

ENTER NAME > [C:\EZ-CAM] APPEARS AT LOWER LEFT.

Type A:\ or B:\ depending on which drive you are using.

Press ENTER RETURN

A:\ or B:\ should now appear at the **1> DIR** of the second level menu.

At this point, you should save the geometry that has been created.

Select **3> PART NAME**

ENTER NAME appears at lower left in the prompts and messages area

Choose a name such as punch die, etc.

Type part name

Press ENTER RETURN. Part name now appears at **3> PART NAME**

Select **4> SAVE**

Select **2> GEOMETRY** from third level menu

(At this point you can only save geometry because that is all that has been created)

GEOMETRY SAVED appears in the prompts and messages area.

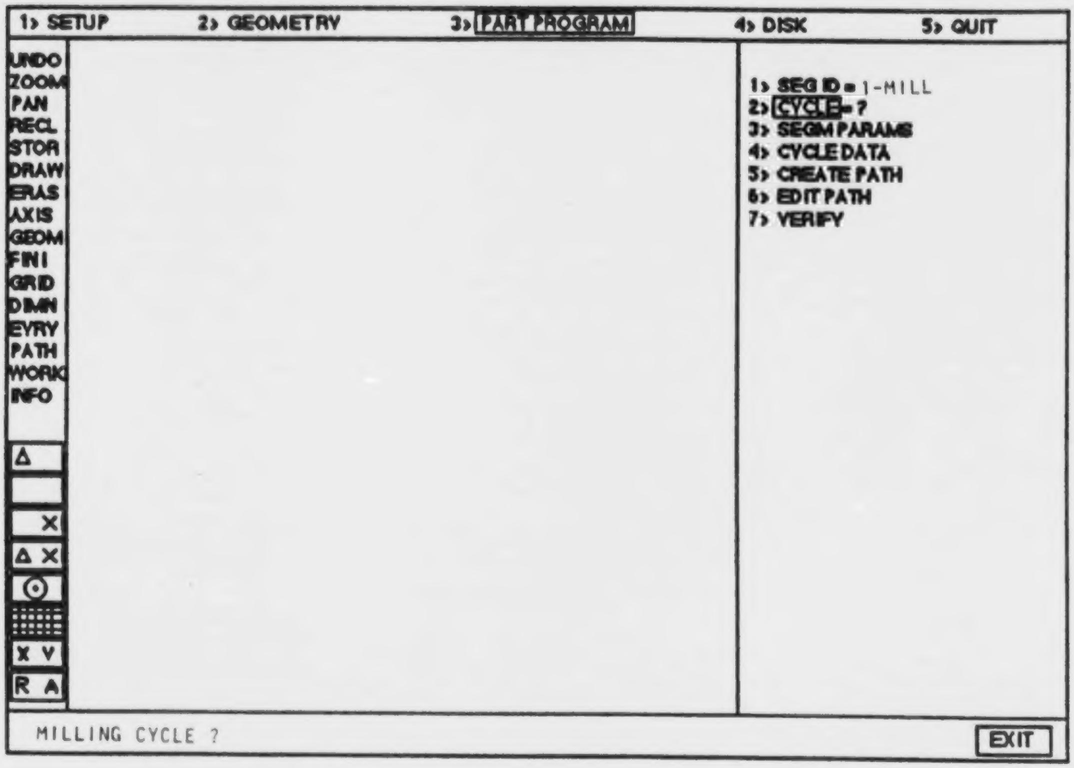
Note: ***The small light on the disk drive will be active during save procedure.***

Select part program from top menu

SEG ID> appears in the prompts and messages area.

Note: ***The first segment ID should be a number one followed by a dash with a descriptive word. Type 1-Mill***

Press **ENTER RETURN**


1> SETUP
2> GEOMETRY
3> PART PROGRAM
4> DISK
5> QUIT
UNDO
ZOOM
PAN
RECL
STOR
DRAW
ERAS
AXIS
GEOM
FINI
GRID
DIMN
EVRY
PATH
WORK
INFO
Δ
X
Δ X
X Y
R A
EXIT

1> SEG ID = 1-MILL
2> CYCLE = ?
3> SEGM PARAMS
4> CYCLE DATA
5> CREATE PATH
6> EDIT PATH
7> VERIFY

MILLING CYCLE ?

2> CYCLE=? appears

Milling Cycle? appears in the prompts and messages area.

Type or select Y

Select 1> **CONTOUR MILL**

(This selection was made because of the machining required.)

Select 3> **SEGM PARAMS**

Select 1> **TOOL INFO**

Select 3> **EFF TL DIA**

Type .625

Press ENTER RETURN

Select 4> **TL CHG(X)**

Type -4

Press ENTER RETURN

Select 5> **TL CHG(Y)**

Type -1

Press ENTER RETURN

Select 7> **COOLANT** (Toggle to your choice)

```
TOOL INFO

  Tool number =  1
  Fixture  number =  1
  Effective tool diameter =   0.625000
  Tool change point X =  -4.000000
  Tool change point Y =  -1.000000
  Coolant = FLOOD
```

Select **2> SPEEDS AND FEEDS**

Select **1> SP SPEED**

Type 400

Press **ENTER RETURN**

```
FEEDS & SPEEDS

 SPINDLE SPEED  = 400 CLOCKWISE
 Plunge feed =    5.000000
 Mill feed =   10.000000
 Feed modify = off
```

Select **3> Z DATA**

Select **2> Z DEPTH**

Type 1

Press **ENTER RETURN**

Select **5> Z STEP**

Type .330

Press **ENTER RETURN**

Select **4> CYCLE DATA** from second level menu

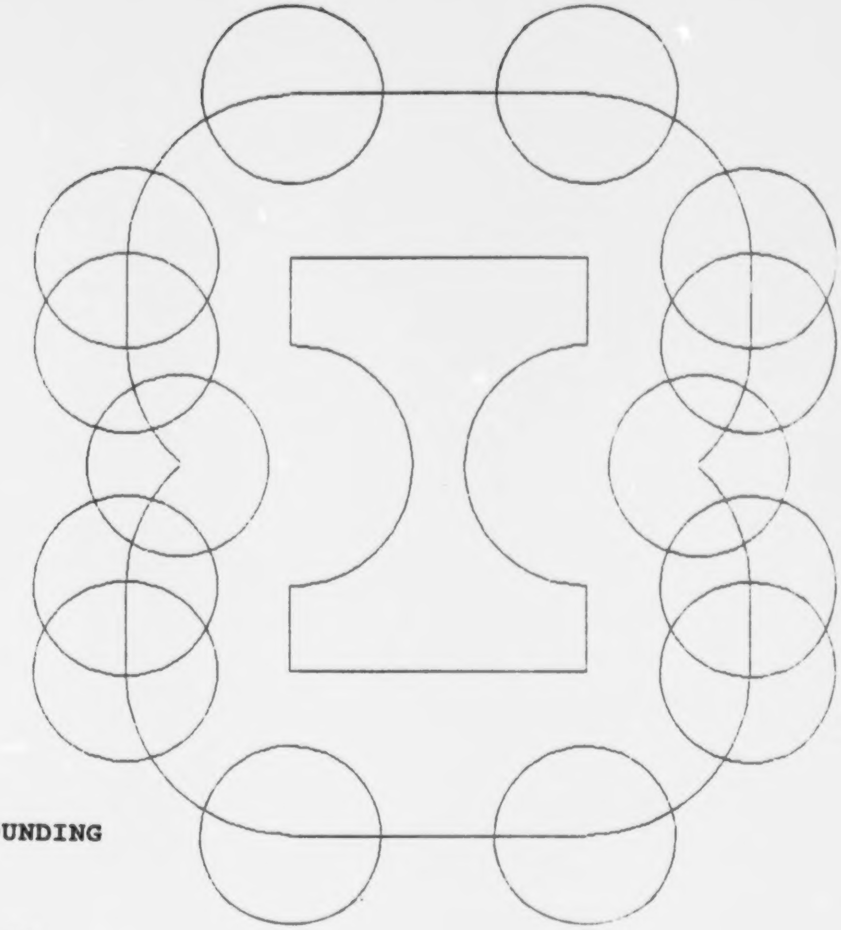
Select **1> OFFSET DIR**

Toggle the mouse until LEFT shows

Select **2> OFFSET VAL**

Type .5625 (This dimension is a result of one half the cutter diameter plus one quarter of an inch)

Press **ENTER RETURN**



Select 3> **AUTO ROUNDING**

Toggle to **ON**

Select 4> **PLUNGE DIS**

Type .5

```
CYCLE DATA

  Offset direction = left
  Offset value =   0.562500
  Automatic corner rounding = on
  Plunge distance =   0.500000
  Tabcyl tolerance =   0.010000
  Cutter Comp = OFF
  Comp value =   0.000000
```

Press ENTER RETURN

Select 5> **MACRO**

Toggle to **ON**

Select 5> **CREATE PATH** from second level menu

Select 1> **DEFINE**

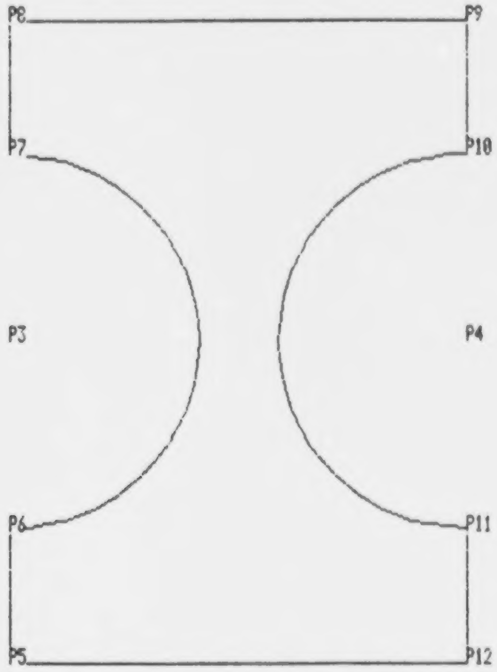
Select 2> **LINEAR**

Note △ point icon is not highlighted.

Place cursor on ☒ intersection icon.

Click button on mouse and ☒ intersection icon will become active.

Check the print for point number five.



PICK INT POINT WITH CURSOR appears at the lower left.

Place the cursor near point five and click the mouse.

Place the cursor on point six and click the mouse.

Select **4> ARC C-CW**

Place the cursor on point seven and click the mouse.

Select **2> LINEAR**

Place the cursor on point eight and click, point nine and click, point ten and click.

Select **4> ARC C-CW**

Place the cursor near point eleven and click the mouse.

Select **2> LINEAR**

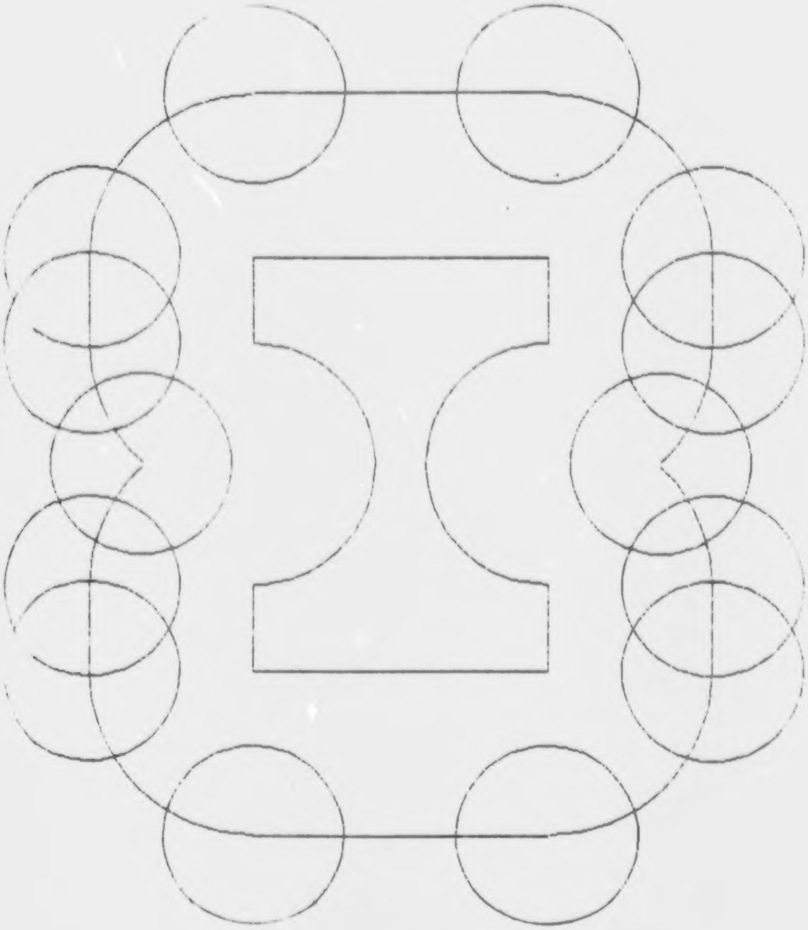
Place the cursor on point twelve and click the mouse.

Select ▲ point icon. (The path must be closed with a point.)

Place cursor at point five and click the mouse. Your path is now complete.

Select **7> VERIFY CHK**

Your cutter path will now appear in yellow and the cutter will appear in red.



Select 1> **SEG ID**

SEGMENT ID> appears at lower left

Type 2-MILL

<u>Note</u>: In the 2-MILL, the 2 represents the second milling operation. All the remaining segments will have progressively larger numbers.

Press **ENTER RETURN**

Milling cycle appears at lower left. Click above $\frac{Y}{N}$ line or type **Y** for yes.

Select 1> **CONTOUR MILL**

Select 3> **SEGM PARAMS**

Select 1> **TOOL INFO**

<u>Note</u>: *The tool info will all show up with the previous values showing. Change only if necessary.*

Select 2> **FEEDS AND SPEEDS**

Keep the choices the same as the previous segment.

```
TOOL INFO

  Tool number =  1
  Fixture  number =  1
  Effective tool diameter =   0.625000
  Tool change point X =  -4.000000
  Tool change point Y =  -1.000000
  Coolant = FLOOD


FEEDS & SPEEDS

 SPINDLE SPEED  = 400 CLOCKWISE
 Plunge feed =    5.000000
 Mill feed =   10.000000
 Feed modify = off
```

Select 3> **Z DATA**

Select 2> **Z DEPTH**

Type .75 (This will leave a one quarter inch piece of steel for the ball mill radius.)

Press ENTER RETURN

Other values stay the same.

```
                Z  DATA

                  Zsurf =    0.000000
                  Zdepth =    0.750000
                  Zrapid =    0.050000
                  Zclear =    0.050000
                  Zstep =    0.330000
```

Select 4> **CYCLE DATA**

Select 2> **OFFSET VAL**

Type .3225 (This is one half the cutter diameter plus ten thousandths)

Press ENTER RETURN

Select 4> **PLUNGE DIS**

Type 0

Press ENTER RETURN

```
          CYCLE DATA

              Offset direction = left
              Offset value =   0.322500
              Automatic corner rounding = on
              Plunge distance =   0.000000
              Tabcyl tolerance =   0.010000
              Cutter Comp = OFF
              Comp value =   0.000000
```

Select **5> CREATE PATH**

Select **3> COPY**

SEGMENT ID appears at lower left

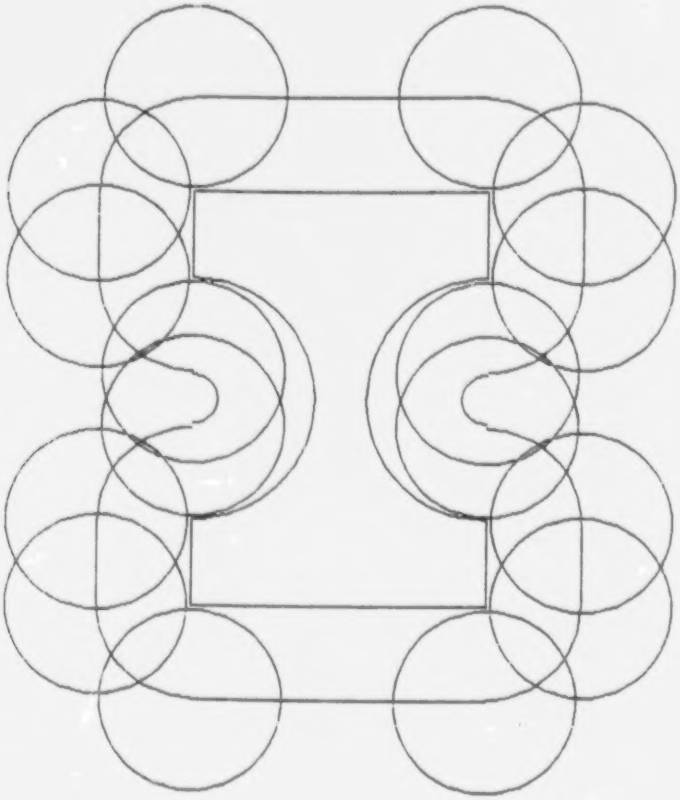
Type **1** (We selected copy above in order to copy path one.)

Press ENTER
RETURN

PATH COPIED appears at lower left

Select **7> VERIFY**

Select **2> VERIFY CHK**



(Your cutter and path now show on the screen.)

Select 1> **SEG ID**

SEGMENT ID appears at lower left

Type **3-FIN MILL**

MILLING CYCLE? appears at lower left

Click your mouse with cursor above the $\frac{\text{Y}}{\text{N}}$ line or type Y for yes.

Select 1> **CONTOUR MILL**

Select 3> **SEG PARAMS**

Select 1> **TOOL INFO**

Keep choices the same as the previous segment.

```
TOOL INFO

  Tool number =  1
  Fixture  number =  1
  Effective tool diameter =   0.625000
  Tool change point X =  -4.000000
  Tool change point Y =  -1.000000
  Coolant = FLOOD
```

Select 2> **FEEDS AND SPEEDS**

Keep choices the same as the previous segment.

```
FEEDS & SPEEDS

 SPINDLE SPEED  = 400 CLOCKWISE
 Plunge feed =   5.000000
 Mill feed =   10.000000
 Feed modify = off
```

Select **3> Z DATA**

Select **5> Z STEP**

Type **.75**

Press ENTER
RETURN

```
     Z  DATA

       Zsurf =    0.000000
       Zdepth =    0.750000
       Zrapid =    0.050000
       Zclear =    0.050000
       Zstep =    0.750000
```

(Z STEP was set the same as Z DEPTH because we are finish milling the side of the part.) (You could have used zero for Z STEP value.)

Select **4> CYCLE DATA**

Select **2> OFFSET VALUE**

Type .3125

Press ENTER
RETURN

The remaining values can stay the same.

```
     CYCLE DATA

       Offset direction = left
       Offset value =    0.312500
       Automatic corner rounding = on
       Plunge distance =    0.000000
       Tabcyl tolerance =    0.010000
       Cutter Comp = OFF
       Comp value =    0.000000
```

(Offset value was set at exactly one half the cutter diameter because this is the finish cut.)

Select **5> CREAT PATH**

Select **3> COPY**

SEGMENT ID appears at lower left.

Type **2**

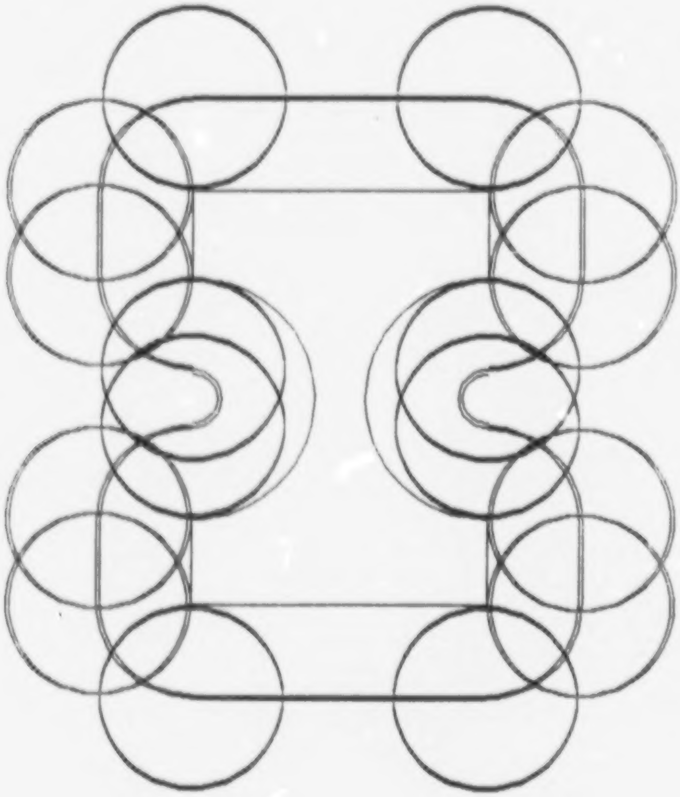
Press ENTER RETURN

PATH COPIED appears

Select **7> VERIFY**

Select **2> VERIFY CHK**

Cutter path and cutter appear on the screen.



Select **1> SEG ID**

SEGMENT ID appears at lower left

Type **4 - BALL MILL**

Press ENTER RETURN

MILLING CYCLE? appears at lower left

Press **Y** for yes

Select **1> CONTOUR MILL**

Select **3> SEGM PARAMS**

Select **1> TOOL INFO**

Select **1> TOOL #**

Type **2**

Press ENTER RETURN

Select **3> EFF TL DIA**

Type **.5**

Press ENTER RETURN

The remaining values can stay the same

```
TOOL INFO

  Tool number =  2
  Fixture  number =  1
  Effective tool diameter =   0.500000
  Tool change point X =  -4.000000
  Tool change point Y =  -1.000000
  Coolant = FLOOD
```

Select **2> FEEDS AND SPEEDS**

Select **1> SP SPEED**

Type 300

Press ENTER RETURN

Select **2> PLUNGE FEED**

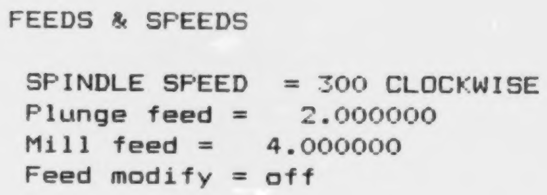
Type **2**

Press ENTER RETURN

Select **3> MILL FEED**

Type **4**

Press ENTER RETURN



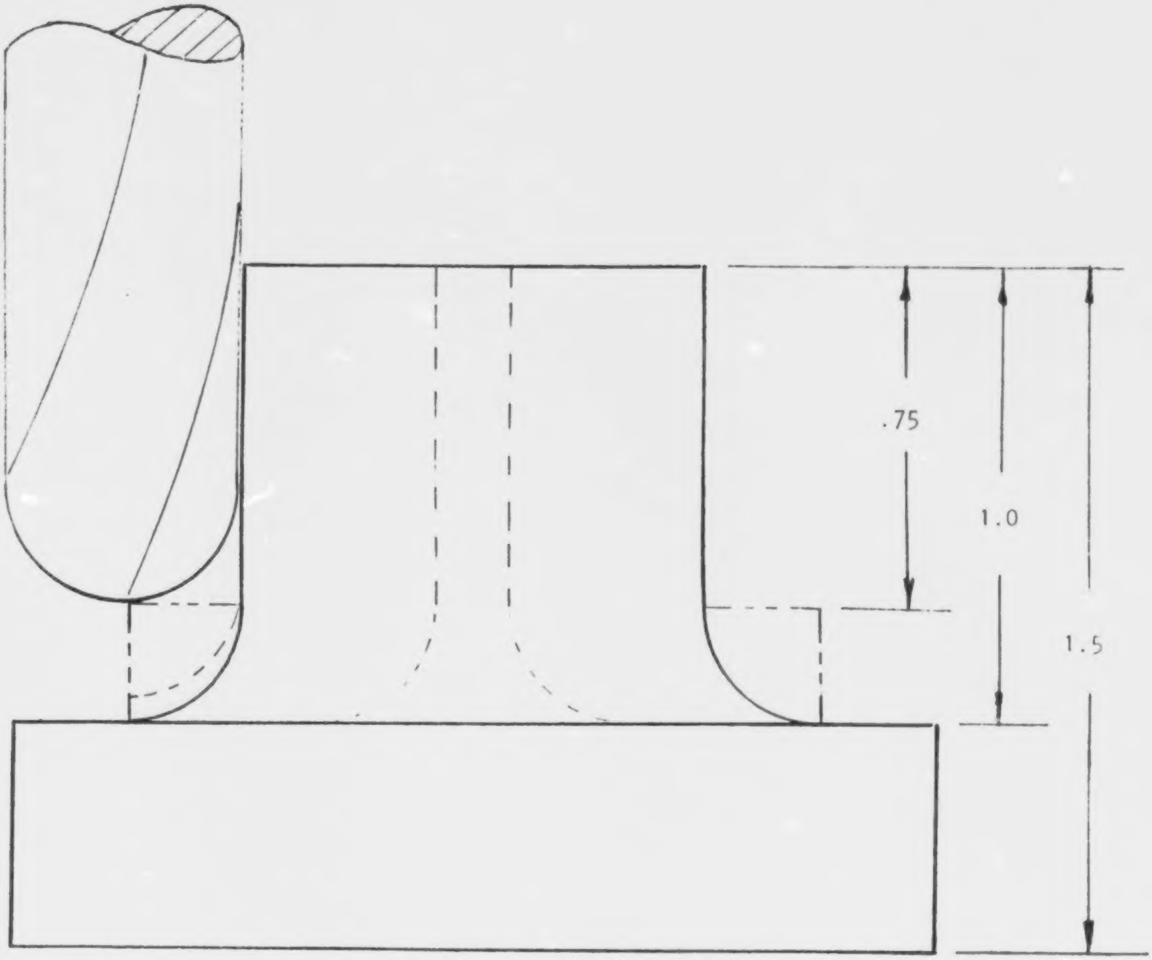
```
FEEDS & SPEEDS

 SPINDLE SPEED  = 300 CLOCKWISE
 Plunge feed =   2.000000
 Mill feed =   4.000000
 Feed modify = off
```

Select **3> Z DATA**

Select **1> Z SURF**

Type -.75. Z SURF is the surface that our tool will rapid to. It is three quarters of an inch from the top of the part.

Press ENTER RETURN



Select **2> Z DEPTH**

Type **.25**

Press ENTER RETURN

Select **5> Z STEP**

Type **.2**

Press ENTER RETURN

```
                Z  DATA

                  Zsurf =  -0.750000
                  Zdepth =   0.250000
                  Zrapid =   0.050000
                  Zclear =   0.050000
                  Zstep =   0.200000
```

Select **4> CYCLE DATA**

Select **2> OFFSET VALUE**

Type **.26**. (This is one half the ball mill diameter plus ten thousandths for clearance.)

Press ENTER RETURN

The remaining values can stay the same.

```
                CYCLE DATA

                  Offset direction = left
                  Offset value =   0.260000
                  Automatic corner rounding = on
                  Plunge distance =   0.000000
                  Tabcyl tolerance =   0.010000
                  Cutter Comp = OFF
                  Comp value =   0.000000
```

Select **5> CREAT PATH**

Select **3> COPY**

SEGMENT ID appears at lower left

Type **3**

Press ENTER
RETURN

Select **7> VERIFY**

Select **2> VERIFY CHK**

Select **4> DISK** from top level menu

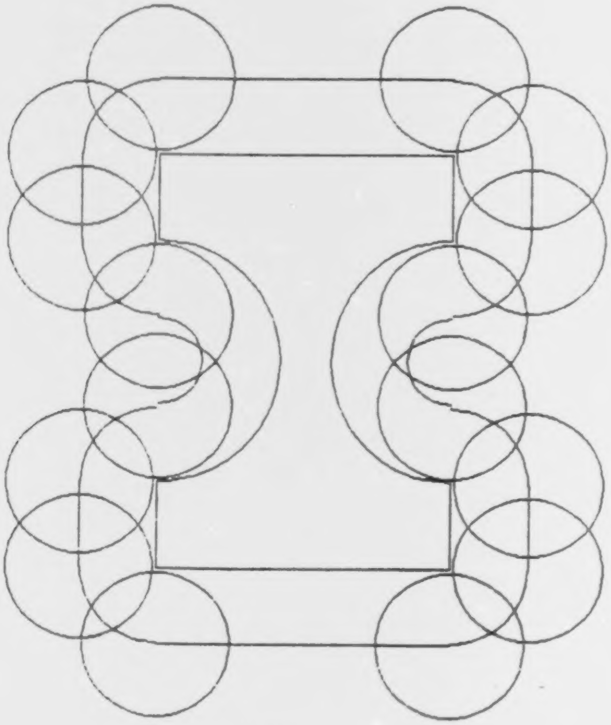
Select **4> SAVE**

Select **1> PART PROGRAM**

PART PROGRAM saved appears at lower left

Select **2> GEOMETRY**

GEOMETRY SAVED appears at lower left



Select **EXIT SIPP** from second level menu

CONFIRM appears at lower left

Select **Y** (for Yes)

Select **POST**

* Use these directions if INT1 is not loaded on your personal disk.

Select **1> DIR = A:**

ENTER NAME appears with either A:\ or B:\

Type C:\EZ-CAM (no spaces)

Press ENTER RETURN, **C:\EZ-CAM** appears

Select **CNC NAME**

ENTER NAME appears at lower left

Type INT1 (for mill)

Press ENTER RETURN

DO YOU WANT TO LOAD INT1? appears

Type Y for Yes

READING INT1 appears at lower left, followed by **CNC INFO LOADED.**

Change dir from C:\EZ-CAM to A:\ or B:\ depending on which drive you are using, as follows.

Select **1> DIR**

Enter name >[C:\EZ-CAM] appears at lower left

Type A:\ or B:\ depending on which drive you are using.

Press ENTER RETURN

A:\ or B:\ now appear at 1> DIR

Select **4> PART NAME**

ENTER NAME appears at lower left

Type **POCKET**

Press ENTER RETURN

Select **5> OUTPUT NAME**

ENTER NAME appears at lower left

Type output name as a number only. It will accept up to six numbers.

Press ENTER RETURN

Select **6> NC OPTIONS**

Options should appear as below:

1> START BLOCK = 0

2> BLOCK INCREM = 1

3> INSERT MODE = OFF

4> SCREEN LIST = ON

5> PRINTER LIST = ON

Select **7> SAVE OPTIONS**

OPTIONS SAVED appears at lower left

Select **8> RUN** (This means you will get a printed copy providing the printer is on and connected to your computer.)

ARE YOU SURE? appears at lower left

Click mouse with cursor above yes/no line, for yes. You could also type Y for yes.

Note: After the part program is processed, the last line on the screen will say:

Part program processed ... Hit <RETURN> to continue

Press **ENTER RETURN**

Select **9> QUIT** from second level menu

DO YOU WANT TO EXIT POST? appears at lower left

Type Y or click mouse with cursor above the yes/no line.

Notes:

TO DOWNLOAD TO THE CNC BRIDGEPORT INT1 MILL

Introduction

After a program has been created on the EZ-CAM, it is saved on a computer disk. A post processor is then utilized to convert the program to the input format of the selected CNC machine tool. POST transforms the part program into an ASCII (American Standard Code for Information Interchange) CNC part program file. This file can then be sent to the machine to produce the part.

Objectives

Upon successful completion of this unit, the student will:

1. Be able to transfer a file to the machine tool.
2. Be able to identify the controls on the machine tool.
3. Be able to enter a file number using the programming and editing key and external data transfer key.
4. Be able to select the proper arrow keys when highlighting the program.

TO DOWNLOAD TO THE CNC BRIDGEPORT MILL

Select **5> UTILITIES**

Select **2> CNC COMMUNICATIONS**

Select **8> LOAD INTERACT**

Select **3> FILE NAME**

ENTER NAME ?, Appears in the prompts and messages area

IMPORTANT! Enter your file name as a number only. Use four numbers or less (Note: It will accept up to eight).

Press ENTER RETURN

Select **5> TO INTERACT**

READY TO TRANSFER appears in the prompts and messages area

Go to the machine tool that is connected to your EZ-CAM unit.

At the machine tool, turn the machine on at the right hand side (Large red rotary switch). Make sure the red buttons are pulled out on the control panel of the machine and on the machine tool head. Turn C.C.W. and the buttons will release. (The screen will appear as below.)

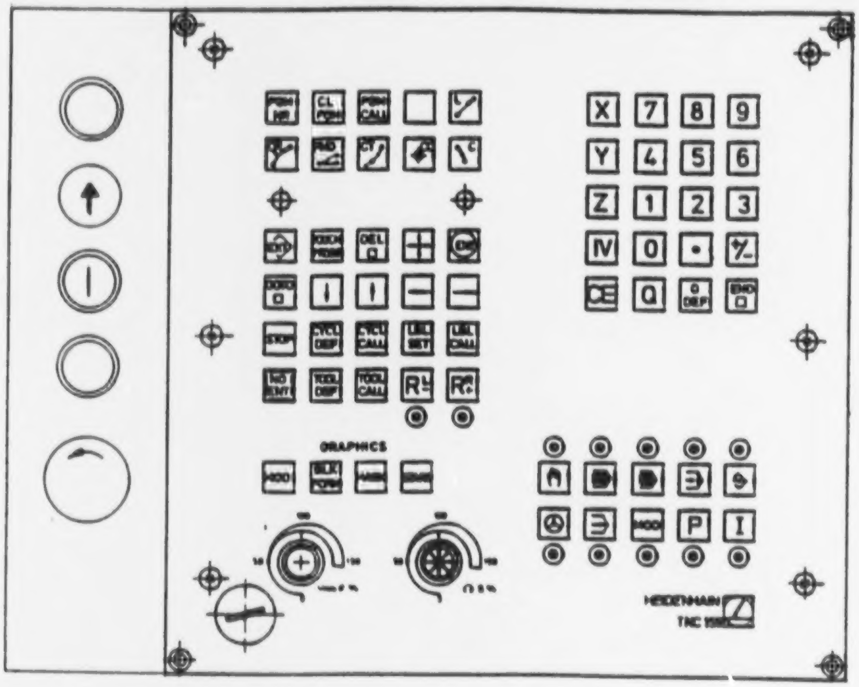
MEMORY TEST

Wait until the following picture appears.

POWER INTERRUPTED

Press CE   Note: If "Relay Ext. DC Voltage" appears, release both red buttons as stated above.

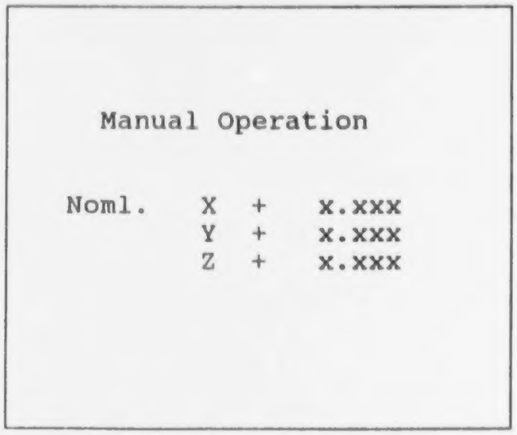
The screen will tell you to: Pass Over Z Reference Mark
Pass Over Y Reference Mark
Pass Over X Reference Mark



Press the amber power on switch. ○

Press the green cycle start button four times. There are times when it takes more than four, so press the green button until the picture appears as below. The first two times will reference the Z pos. limit. The third will reference the Y pos. limit and the fourth time will reference the X pos. limit.

NOTE: Wait for the machine to stop moving after each push of the green button. The screen will appear as shown below.



```
        Manual Operation


Noml.    X  +   x.xxx
         Y  +   x.xxx
         Z  +   x.xxx
```

Press ⇨ (PROGRAMMING AND EDITING KEY)

Press EXT (EXTERNAL DATA TRANSFER KEY)

```
PROGRAMMING AND EDITING
SELECTION=ENT  /  END=NOENT


PROGRAM DIRECTORY
READ-IN ALL PROGRAMS
READ-IN PROGRAM OFFERED
READ-IN SELECTED PROGRAM
READ-OUT SELECTED PROGRAM
READ-OUT ALL PROGRAMS
```

Toggle by pressing:

↑ ↓ until the orange background covers, read in selected program, from the six choices.

The top highlighted line says, ENT or NO ENT, press ENT.

Type in the program number x x x

Press ENT. When program number appears at upper left, press ENT.

W A I T !!

You must give the equipment time to transfer the data. Again, the EZ-CAM screen will blank out in the prompts and messages area. During transferring it said **TRANSFERRING TO CNC**.

When the machine tool screen appears as below, the transfer is complete.

NOTE: At this point the EZ-CAM screen will stop displaying transferring to CNC.

```
        PROGRAMMING AND EDITING

0    Begin PGM  x x x          Inch

1    Tool Call                    Z

2    LX - 4.0000        Y - 1.0000

                         ROF3999M25
-------------------------------------
```

Note: ***Do not use* CE *unless you entered the wrong information. It will clear your last entry and you can just press a different key if the top prompt says, "Key Non-Functional."***

Press → (PROGRAM RUN/FULL SEQUENCE)

The program was in editing memory and we must bring it into run memory.

NOTE: The top line at the machine tool has changed from programming and editing to program run/full sequence.

Press PGM NR The following appears

Program Selection

Program Number =

IMPORTANT: If more than one program number appears, use arrow keys to highlight your choice. If only one program appears, type your program number. ↑ ↓

Press ENT

```
                  PROGRAM RUN/FULL SEQUENCE

        0    BEGIN PGM  123                  INCH

        1    TOOL CALL                          Z
                        S
        2    L X  X.XXXX              Y - X.XXXX

                                      R0  FXXXX       M25
---------------------------------------------------------------

     NOML.  X - X.XXXX                Y + X.XXXX
            Z + X.XXXX
                                                      M5/9
```

Notes:

SETTING TOOL LENGTH OFFSETS (TLO)

Introduction

It is necessary to set tool lengths in reference to the top of the part. The accepted practice is to set your longest tool first, each tool to follow that is shorter will have a negative tool length compensation. If any tool would be longer than your first tool (tool zero), the difference is entered as a positive tool length compensation.

Objectives

Upon successful completion of this unit, the student will:

1. Be able to enter an interpolation factor which will vary the handwheel movement per revolution.
2. Be able to properly assemble the collet assembly.
3. Be aware of the safety light on the machine tool head when changing tools.
4. Be able to find the tool definitions on the screen (CRT) by using the arrow keys.
5. Be able to enter tool lengths (L) from the keypad while in programming editing.
6. Be able to use the handwheel when touching off the top of the part with tooling.
7. Be able to transfer data into the (L) of tool two by using the transfer/enter actual position key.

How To Set Tool Length Offsets

Press ⇨ (PROGRAMMING AND EDITING)

Press PGM NR (PROGRAM NUMBER)

Highlight the program number using arrow keys or type the program number and

Press ENT .

Press ☸ (HANDWHEEL)

Enter an interpolation factor from two to ten which will vary the hand wheel movement per revolution as follows.

__Note__: Your selection will appear to the right of interpolation factor.

After pressing your selection,

Press ENT .

2 = .19685

3 = .098

4 = .049

5 = .026

6 = .0123

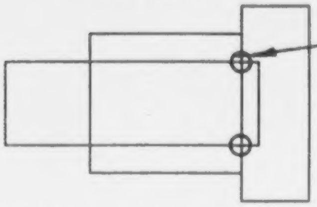
7 = .006

8 = .003

9 = .0015

10 = .00078

Note: Snap collet into tool holder prior to tool insertion in collet.



Snap ring must be engaged with collet.

Now lightly assemble the tool holder. Insert cutter, place in tool holder block, and tighten.

Caution: Press green button on spindle prior to tool change. It must light up.

Place tool number one into spindle and tighten in place. Make sure your screen reads Z-axis.

While in ☸, (hand wheel), take your first tool and touch the top of your work piece with the cutting tool.

Press ✋ (MANUAL OPERATION)

Press Z

Press . 0 0 0 0

Press ENT

Press ⇨ (PROGRAMMING AND EDITING)

Find TOOL DEF 1 line by using the ↓ down arrow key.

TOOL DEF 1 must be placed second from the top of the four numbered lines.

The L should be 0. If it isn't, toggle →, right arrow, until the L is highlighted.

Enter 0.0000 from the keypad. Use →, right arrow, twice or until all highlighting is off the screen.

If you are only using one tool, go to **EDGE FINDING**. If you are using two or more tools, continue as follows.

Press ☸ (HANDWHEEL)

Caution: Press green button on spindle prior to tool change. It must light up.

Remove Tool 1

Insert Tool 2

Approach top of part with either rapid lever (joystick) and/or handwheel.

Touch the top surface of the part.

Leave tool #2 on the surface.

Press ⇨ (PROGRAMMING AND EDITING)

Find "TOOL DEF 2" line by using the arrow keys or reference your post printout to find the line number for TOOL DEF 2.

Press GOTO □

Enter desired number.

Press ENT

You are now at TOOL DEF 2.

Highlight the "L" using → right arrow key. Make sure the small "Z" is highlighted.

Press ✛ (TRANSFER/ENTER ACTUAL POSITION), which transfers the "Z" data into "L".

Press →, right arrow, twice or until all highlighting is off the screen.

Press ☸ (HANDWHEEL)

Repeat the above procedure for the remaining tool definitions.
Caution: Press green button on spindle prior to tool change. It must light up.
Remove Tool 2 and place Tool 1 into spindle.

Notes:

EDGE FINDING

Introduction

It is necessary to locate the edges of a workpiece in order to properly set the machine spindle center over the XO and YO coordinates. To avoid unnecessary calculating, the workpiece datum is located at that point on the part on which the dimensions are based. For reasons of safety, the workpiece datum is almost always located at the highest point of the workpiece on the tool axis.

Objectives

Upon successful completion of this unit, the student will:

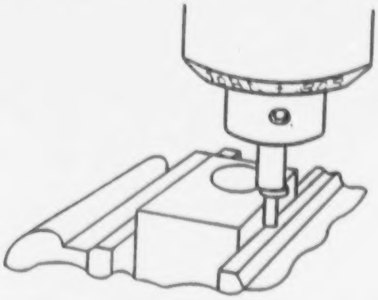
1. Be able to activate the spindle speed by entering (M) codes.
2. Be able to zero out the X and Y by using the proper keys on the control panel.
3. Be aware of the radius value on the edge finder when setting the X and Y locations.
4. Be able to test run a program to check if the table limits haven't been exceeded .
5. Be able to run a program using the program run full sequence operating mode.

EDGE FINDING

Secure work piece on mill.

Press ✋ (Manual Operation)

Insert drill chuck or collet into the spindle. The accuracy required will dictate which tool to use. Place an edge finder into the chuck.



Note: If the knee has to be moved, note location of micrometer collar. This would affect your tool settings if not taken into consideration.

Using the joystick, bring the edge finder into the proper vertical position near the left edge of the part.

Press ⎈ (Handwheel)

Note: Using the numeric key pad and the ENT , enter key, we can now choose the desired interpolation factor (2-course through 10-fine).

Press ✋ (Manual)

Press TOOL CALL (Tool Call)

Insert desired R.P.M. from key pad. Press ENT

BLOCK COMPLETE will be highlighted at top of screen.

Press | , green button

Note: New speed will display at bottom of screen. If it doesn't display, turn brightness control knob at lower right of screen.

Press STOP (Stop Key)

Auxiliary Function M? appears at top of screen.

Using key pad, press 03 (spindle on; clockwise)

Press ENT. **BLOCK COMPLETE** will be highlighted at top of screen.

Press | , green button for start.

M3/9 will appear at lower right of screen.

> Note: If at this time you wanted the spindle turned off:
>
> Press STOP
>
> The top of the screen will say, AUXILIARY FUNCTION M?
>
> Enter 05 on key pad. (05 is the spindle stop "M" code.)
>
> Press | , green button for stop.
>
> Important: Green button activates the M code that you have entered.

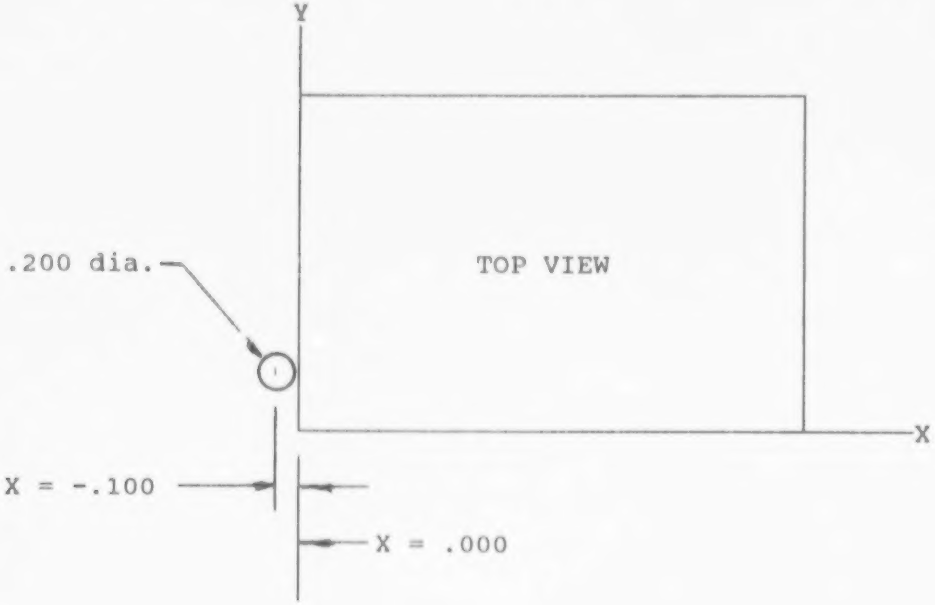
Press ☸ , (hand wheel)

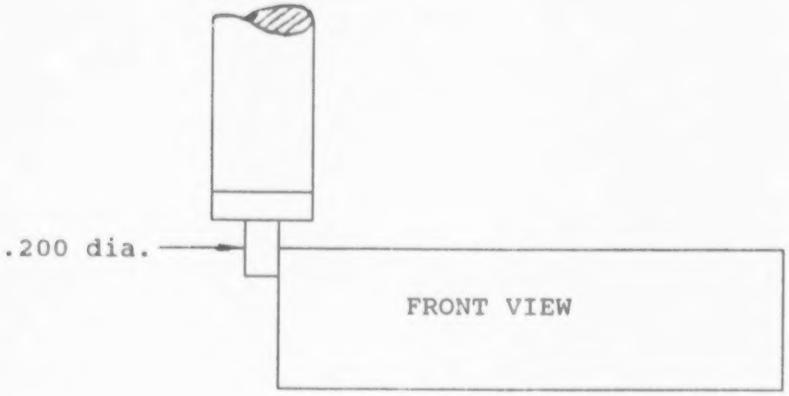
Press X , orange X on key pad.

Using the larger fine feed interpolation factor numbers, approach the edge of your project using the hand wheel until the edge finder flips off center.

Press ✋ (Manual Operation)

Your spindle center line is now .100" from the edge.


Y
.200 dia.
TOP VIEW
X
X = -.100
X = .000


.200 dia.
FRONT VIEW

Press X , orange button

Datum set X = is highlighted

Press +/- and toggle to minus.

Using the numeric key pad, enter .100. We have now entered X = -0.100

Press ENT

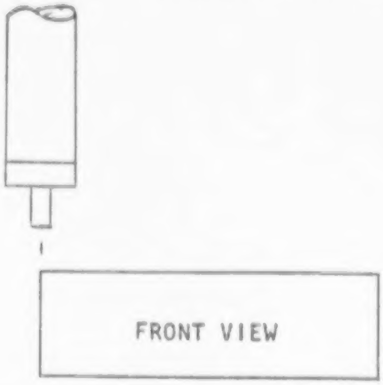
The screen now reads X -.1000

Use the joystick to raise the spindle

Press ☸ (Handwheel)

Use the hand wheel in order to make X = 0.0000

You have now moved the spindle center line directly over the left edge of the part. Eyeball the location for a visual check (See below).



Press ☸ (Handwheel)

Press Y , orange Y on key pad

Using the joystick or course handwheel setting (2), position the edge finder at the front of the part.

Using the fine feed (10) interpolation factor, approach the edge of your part using the handwheel until the edge finder flips off center.

Press ✋ (Manual Operation)

Press Y, orange Y on key pad

Datum set Y = is highlighted at the top of the screen.

Press +/− and toggle to minus.

Using the numeric key pad, enter .100. We have now entered Y = -0.100.

Press ENT

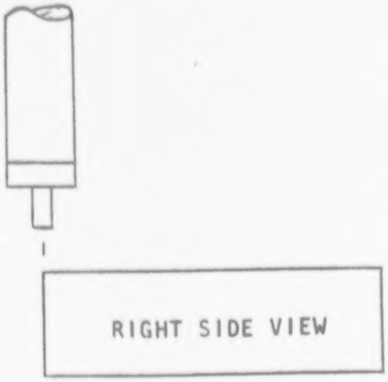
The screen now reads Y - 0.1000

Use the joystick to raise the spindle.

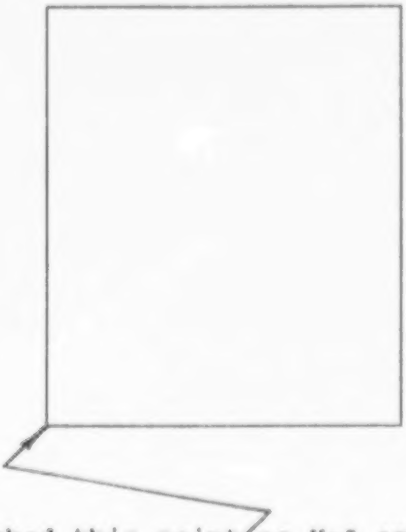
Press ☸ (Handwheel)

Use the handwheel in order to make Y = 0.0000.

You have now moved the spindle center line directly over the front edge of the part. Eyeball the location for a visual check (See below).

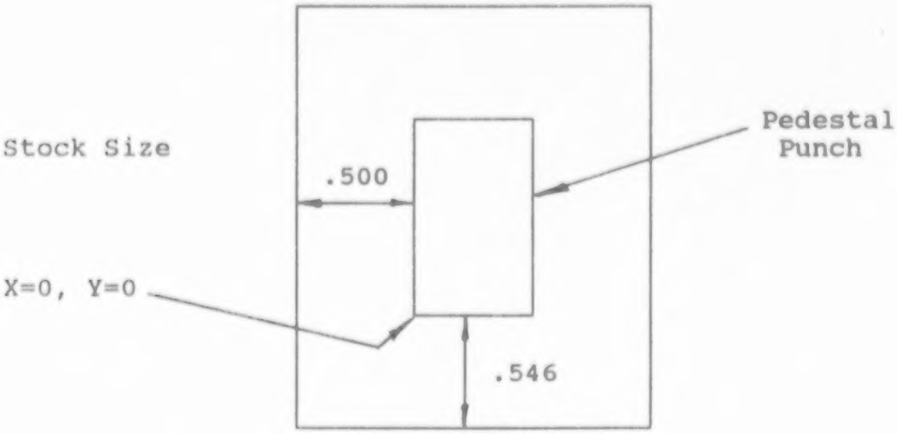


__Note__: The eyeball moves were not necessary; they were just a check.

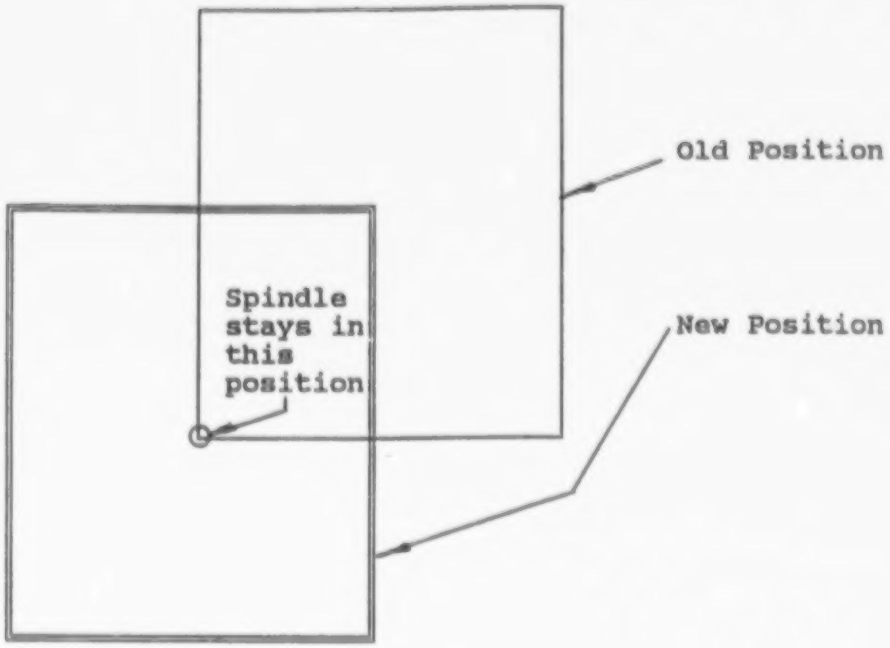


We have now established this point as X=0 and Y=0.

X=0, Y=0 could be located as shown below.

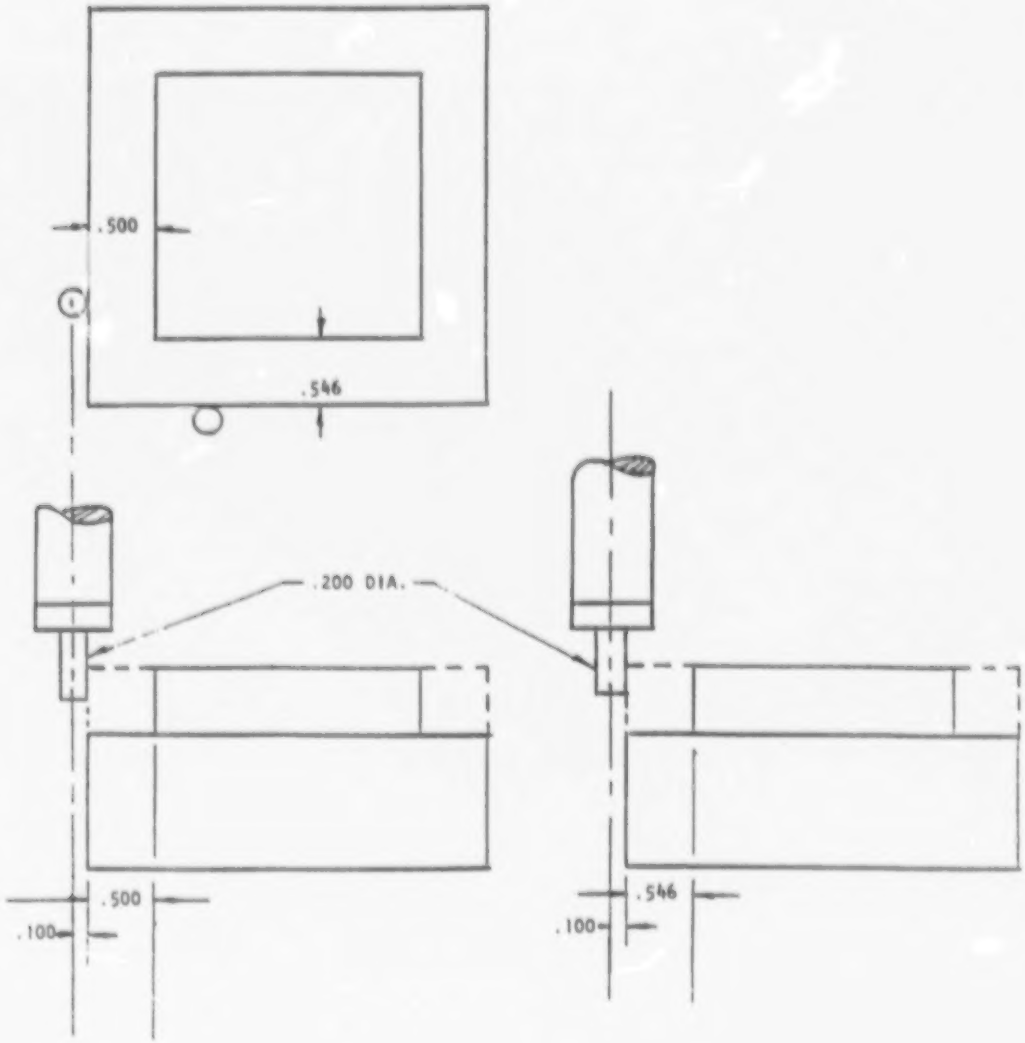

Stock Size
.500
Pedestal Punch
X=0, Y=0
.546

In order to establish the X=0, Y=0 point for the pedestal punch, negative values will have to be entered for the X and Y moves.


Old Position
Spindle stays in this position
New Position

Note: *The part had to move X negative .500 and Y negative .546.*

Note: *The edge finder does not have to be directly over the edge of the part, as long as you account for half the diameter of the edge finder when entering the X and Y values. See below.*


.500
.546
.200 DIA.
.500
.100
.546
.100

You should be at a start point on your part with all the tool length offsets (TLO) set and edges located before you do the test run.

Notes:

HOW TO TEST RUN

Press ⇒ (TEST RUN) Key

Press ↑ arrow up key until the last line of your program appears, note the line number. Press ↓ arrow down key until the 0 line appears.

TO BLOCK NUMBER =, appears. This must now be answered with your last block number. Test run will stop at each tool definition. Re-enter your last block number and press ENT.

NOTE: *The bottom of your screen is active at this time. Type the last block number and press* ENT.

This should be done as many times as necessary until the beginning of your program appears.

If **SELECTED BLOCK NOT ADDRESSED APPEARS**, press GOTO ☐, press 0, press ENT, and then re-try the dry run.

NOTE: *The test run will check that you have not exceeded the table limits.*

Notes:

How To Run Program

Press [→] (PROGRAM RUN FULL SEQUENCE)

Press [PGM NR]. Use arrow keys to highlight the program number. Press [ENT], or type the program number and press [ENT].

Line 0 appears.

Press green button on control panel (|) twice.

Notes:

POCKET MILLING

Introduction

Pocket milling is the process of milling a cavity in a piece part with the cutter plunging to a specified depth and moving in X and Y increments until the geometric form has been satisfied.

Objectives

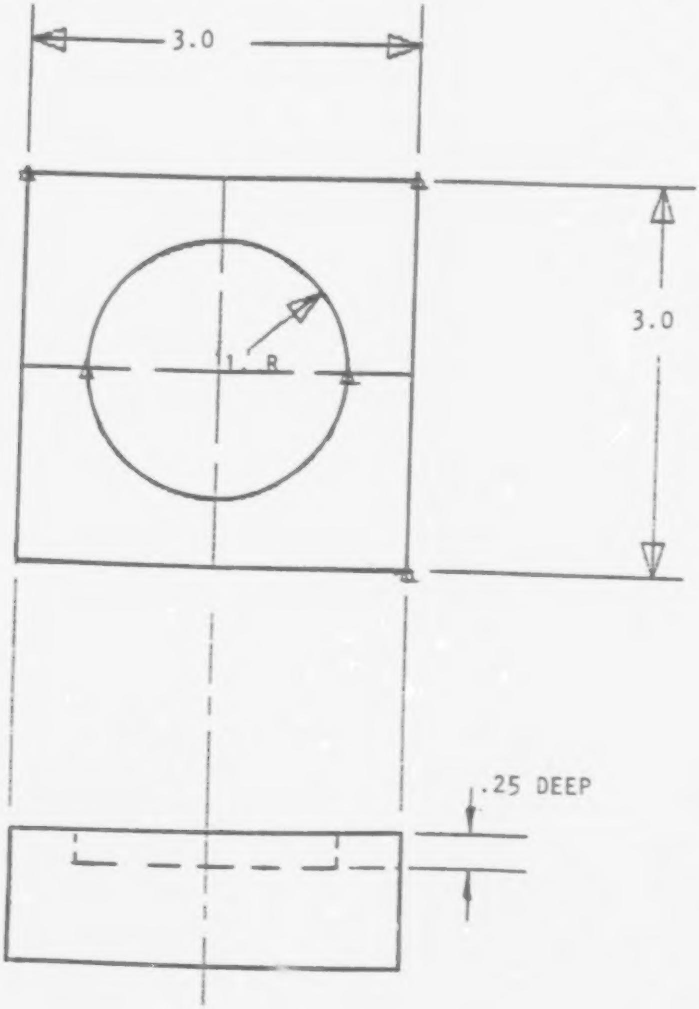
Upon successful completion of this unit, the student will:

1. Be able to set tool change positions, speeds, feeds, and tool diameters.
2. Be able to set the Z clearance, Z surface, Z depth, Z rapid, and Z step.
3. Be able to set offset values.
4. Be able to set step over values.
5. Be able to set plunge distance values.
6. Be able to save the part program and geometry.
7. Be able to load INT1.
8. Be able to set and save NC options.

Milling A Pocket Using The Pocket Mill Cycle

Create the necessary part geometry for a circular pocket shown below.

Note: The circle must have two points on it for a circular program to work.



Segment I.D. appears.

Type, 1 - Pocket.

Note: The dash (-) between the number one and pocket will enable you to recall segments by just typing the segment number.

Press ENTER RETURN

After pressing ENTER RETURN, **2> CYCLE = ?**, appears in the second level menu. **MILLING CYCLE?** also appears in the prompts and messages area.

Click the mouse with the cursor above the yes/no line if you want the milling cycle. Then four choices appear in the third level menu.

Note: If you had clicked below the yes/no line, seven non-milling choices would have appeared.

Select **2> POCKET MILL**

POCKET MILL appears in the second level menu.

Select **3> SEGM PARAMS**

Select **1> TOOL INFO**

In the fourth level menu, seven prompts must be satisfied.

Default values appear after each prompt.

For this part, enter values as shown below:

1> TOOL # = 1
2> FIXTURE # = 1
3> EFF TL DIA = 0.5
4> TL CHG (X) = -4
5> TL CHG (Y) = -1
6> TL CHG (Z) = 15
7> COOLANT = OFF

Select **2> FEEDS AND SPEEDS** from the third level menu.

The fourth level menu appears.

Type new values as shown below for the fourth level menu:

1> **SP SPEED = 1000** (High R.P.M. for plastic part)

2> **PLUNGE FEED = 5** (spindle feed rate of 5 I.P.M.)

3> **MILL FEED = 10** (I.P.M. for plastic)

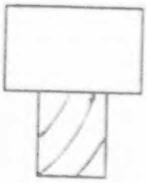
Select **2> Z DATA** from the third level menu.

The fourth level menu appears.

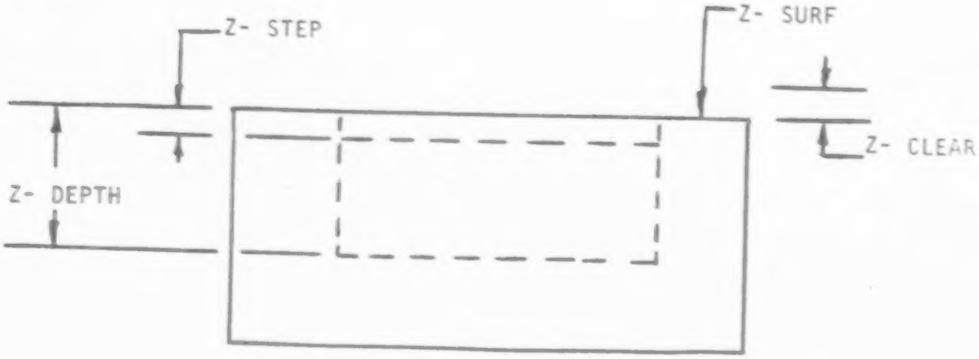
Type new values as shown below:

1> Z SURF = 0
2> Z DEPTH = 0.25
3> Z RAPID = 0.05
4> Z CLEAR = 0.05
5> Z STEP = 0.1

***Note: These values do not use + or - signs.**



***Note: Z-Rapid = Spindle moves fast to within .050 of last cut.**



Skip **4> OTHER PARAMETERS** in the third level menu.

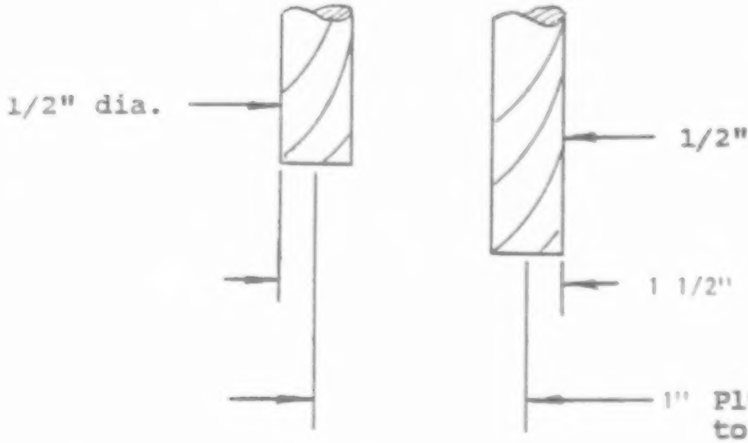
Select **4> CYCLE DATA** from the second level menu.

The four prompts appearing in the third level menu must be satisfied as below:

1> **OFFSET VALUE = .26** (This is one-half the cutter diameter plus .010 for the finish cut.)

2> **STEP OVER = .3** (This entered value is 60% of the cutter diameter, which can vary.)

3> **PLUNGE DIS =** (The horizontal distance the tool travels while going to a specified depth.)



Plunge distance = center to center distance.

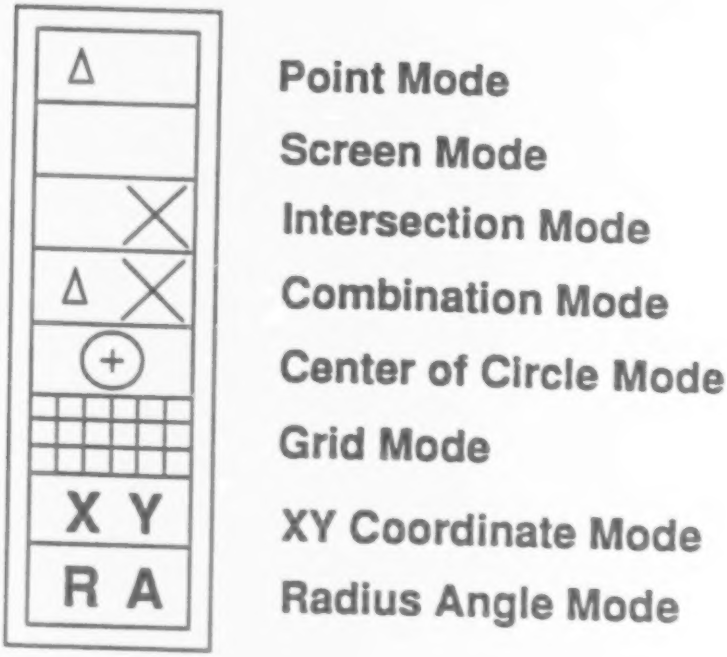
4> **MACRO = ON** (on will let the computer re-use some segments which will shorten the post. Post is the print out of the language accepted by the selected CNC machine tool)

Select **CREATE PATH**

Select **DEFINE** from the third level menu. Eight choices appear in the third level menu. These choices are used to create the cutter path which will depend on the part geometry created.

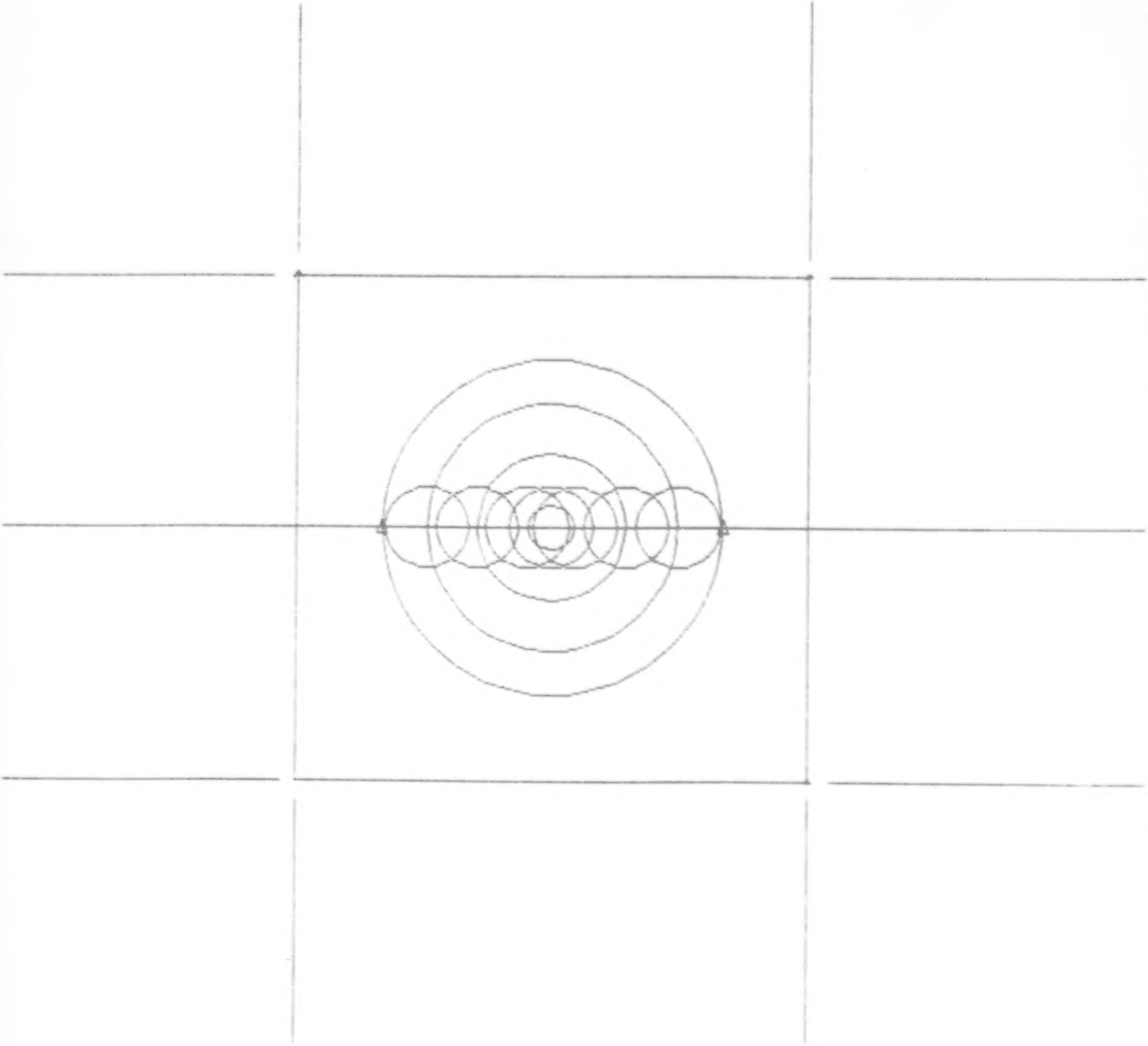
Select **3> ARC CCW**

Select the appropriate icon, Δ


Δ
Point Mode
Screen Mode
Intersection Mode
Δ
Combination Mode
Center of Circle Mode
Grid Mode
X Y
XY Coordinate Mode
R A
Radius Angle Mode

Select 7> **VERIFY** from the second level menu.

Select **2> VERIFY CHK** from the third level menu.



Note: *Circles concentric with the cavity are the tool path. Small circles show the cutter diameter.*

Select **1> SEG ID**

SEGMENT ID> appears in the prompts and messages area.

Type **2 - FINPOCKET** (The machine identifies the number 2 as the second segment. Finpocket is the descriptive term for the operator only)

Note: *The - (dash) must be between the number and the descriptive word or you would have to type the complete name, 2 finpocket, to recall that segment ID.*

Press ENTER RETURN

The **MILLING CYCLE** appears in the prompts and messages area.

Select **Y**

Select **POCKET MILL**

Select **SEGM PARAMS**

Tool info and speeds remain the same.

Select **Z DATA**

Select **Z STEP**

Type 0 (the cutter will go right to Z depth with no steps)

Press ENTER RETURN

Skip **4> OTHER PARAMS**

Select **CYCLE DATA**

Select **OFFSET VALUE**

Type .25 (The offset value is now exactly one-half the cutter diameter for the finish cut of .010)

Do not change values below:

STEP OVER = 0.3
PLUNGE DIS = 0.5
MACRO = ON

Select **CREATE PATH**

Select **COPY** (We can copy the same path from the previous segment ID number. There is no need to re-define the path.)

SEGMENT ID> appears in the prompts and messages area.

Type 1 (This copies the path from segment ID, 1-pocket)

Press ENTER RETURN

PATH COPIED appears at lower left on screen.

Select **VERIFY**

Select **VERIFY CHK**

Note: The part program and geometry must now be saved.

Select **DISK** from the top menu

Important: The **1> DIR** should = A:\ or B:\, depending on which drive your disk is in.

Select **PART NAME**

ENTER NAME appears at the lower left.

Type **POCKET**

Press ENTER RETURN

Select **SAVE**

Select **PART PROGRAM**

WRITING PART PROGRAM appears at lower left

PART PROGRAM SAVED then appears at lower left

Select **GEOMETRY**

WRITING A:\POCKET GEO appears at lower left

GEOMETRY SAVED then appears at lower left

Select **QUIT** from top menu

Select **EXIT SIPP** from second level menu

CONFIRM appears at lower left

Select **Y** (for Yes)

Select **POST**

* Use these directions if INT1 is not loaded on your personal disk.

Select **1> DIR = A:\**

ENTER NAME appears with either A:\\ or B:\\

Type C:\\EZ-CAM (no spaces)

Press ENTER RETURN, **C:\\EZ-CAM** appears

Select **CNC NAME**

ENTER NAME appears at lower left

Type INT1 (for mill)

Press ENTER RETURN

DO YOU WANT TO LOAD INT1? appears

Type Y for Yes

READING INT1 appears at lower left, followed by **CNC INFO LOADED.**

Change dir from C:\\EZ-CAM to A:\\ or B:\\ depending on which drive you are using, as follows.

Select **1> DIR**

Enter name >[C:\\EZ-CAM] appears at lower left

Type A:\\ or B:\\ depending on which drive you are using.

Press ENTER RETURN

A:\\ or B:\\ now appear at 1> DIR

Select **4> PART NAME**

ENTER NAME appears at lower left

Type **POCKET**

Press ENTER RETURN

Select **5> OUTPUT NAME**

ENTER NAME appears at lower left

Type output name as a number only. It will accept up to six numbers.

Press ENTER RETURN

Select **6> NC OPTIONS**

Options should appear as below:

- **1> START BLOCK = 0**
- **2> BLOCK INCREM = 1**
- **3> INSERT MODE = OFF**
- **4> SCREEN LIST = ON**
- **5> PRINTER LIST = ON**

Select **7> SAVE OPTIONS**

OPTIONS SAVED appears at lower left

Select **8> RUN** (This means you will get a printed copy providing the printer is on and connected to your computer.)

ARE YOU SURE? appears at lower left

Click mouse with cursor above yes/no line, for yes. You could also type Y for yes.

Note: After the part program is processed, the last line on the screen will say:

Part program processed ... Hit <RETURN> to continue

Press ENTER RETURN

Select **9> QUIT** from second level menu

DO YOU **WANT TO EXIT POST?** appears at lower left

Type Y or click mouse with cursor above the yes/no line.

Notes:

TRANSLATION/Y-SYMMETRY/ROTATION/SCALING

Introduction

In this unit the student will be able to repeat single items of geometry using translation, Y-Symmetry, Scaling, and Rotation. Translation repeats a single geometric item in an X and Y direction any number of repetitions desired. Y-Symmetry repeats a single geometric item once about the Y axis. Scaling repeats a single geometric item any number of times by a factor greater or less than 1. Rotation is the repetition of a single geometric item any number of times about a point.

Objectives

Upon successful completion of this unit, the student will:

1. Be able to repeat a single geometric item using translation.
2. Be able to repeat a single geometric item using Y-Symmetry.
3. Be able to repeat a single geometric item using scaling.
4. Be able to repeat a single geometric item using rotation.

Repeat Single Using Translation

Select **2> GEOMETRY** (draw your part)

***See the example at the top of the next page.**

Select **1> MODE**

Select **1> DEFINE**

Select **4> CIRCLE**

Select **2> CENTER COORD**

RADIUS is asked for

Type .5

ENTER
RETURN

CENTER X is asked for

Type 0

ENTER
RETURN

CENTER Y is asked for

Type 3

ENTER
RETURN

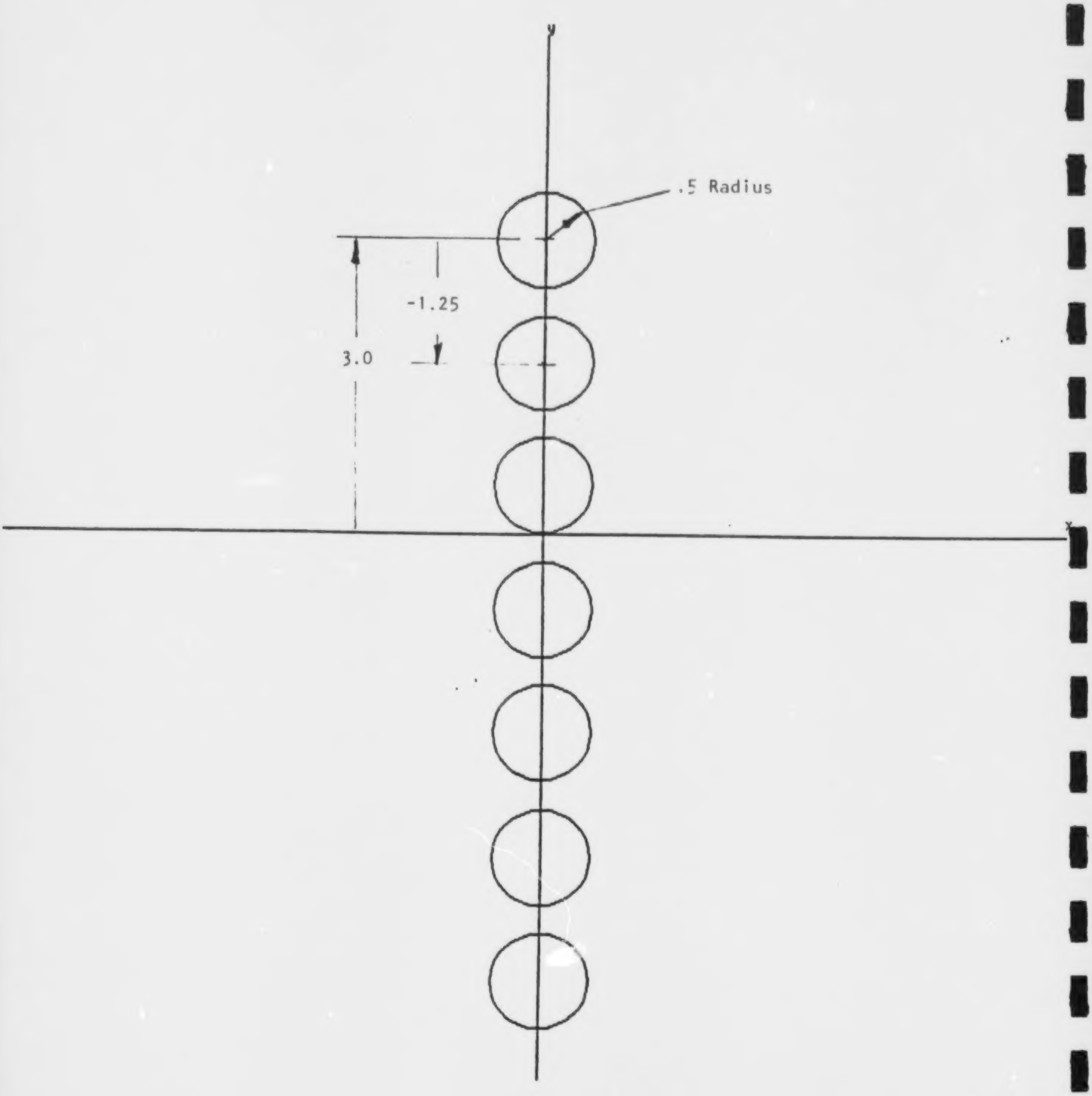
Select **1> MODE**

Select **7> REPEAT SINGLE**

Select **2> TRANSLATION** from third level menu

DO NOT select **3> TRANS CENTER** from second level menu

Repeat Single Using Translation


y
.5 Radius
-1.25
3.0
x

Select **4> PARAMETERS**

Select **1> NUMBER OF COPIES**

Type 6

ENTER
RETURN

Select **2> DISTANCE X**

Type 0

ENTER
RETURN

Select **3> DISTANCE Y**

Type -1.25

ENTER
RETURN

Select **7> CIRCLE**

Pick circle with cursor appears appears

Pick circle with cursor and click mouse

DO YOU WANT TO STORE NEW CIRCLES appears in prompts and messages area

Select Y for Yes

Select 1> **MODE:** This will delete prompts and messages area

Repeat Single Using Y-Symmetry

Select **2> GEOMETRY** (draw your part)

*See the example at the top of the next page.

Select **1> MODE**

Select **7> REPEAT SINGLE**

Select **2> TRANSF**

Select **5> Y-SYMMETRY**

Note: *There are no parameters for this option (Y-Symmetry) other than trans center.*

Select **3> TRANS CENTER**

Note: *You can only enter a value in X> center.*

Select **1> X CENTER**

Type 0

ENTER
RETURN

Select **2> Y CENTER**

Type 0

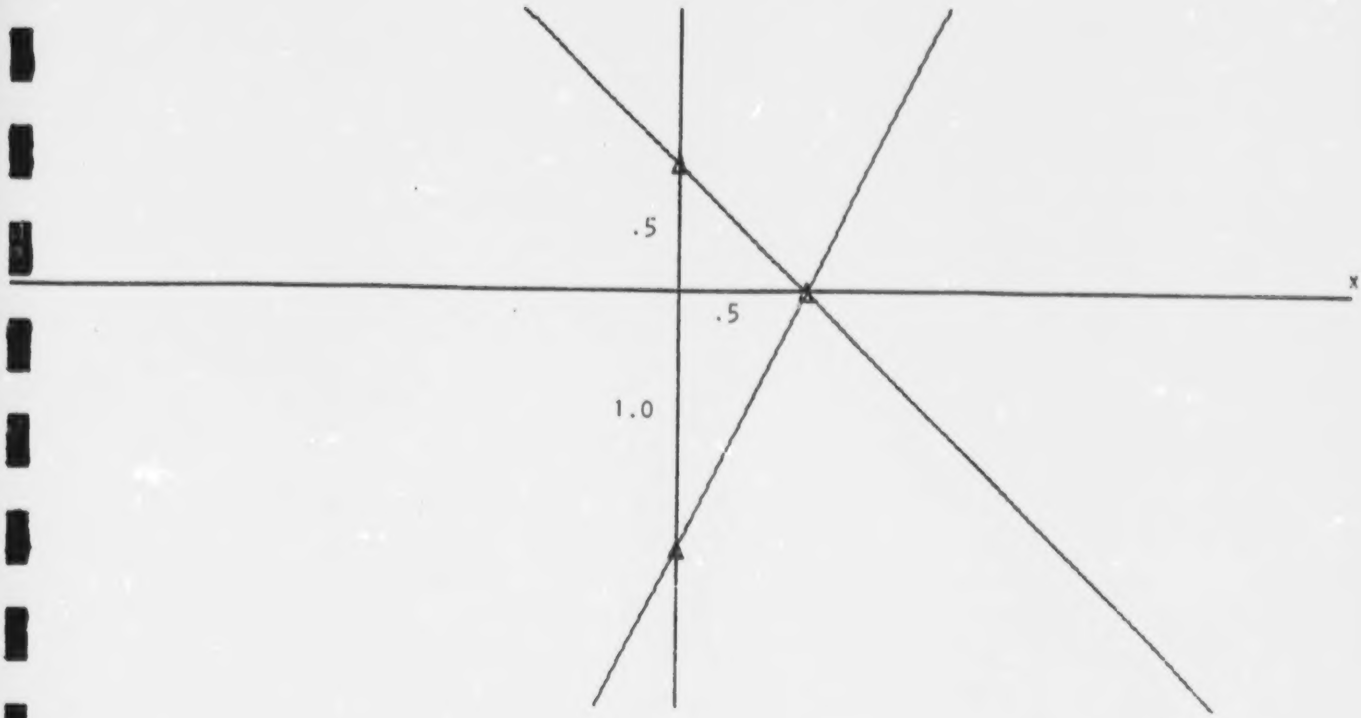
ENTER
RETURN

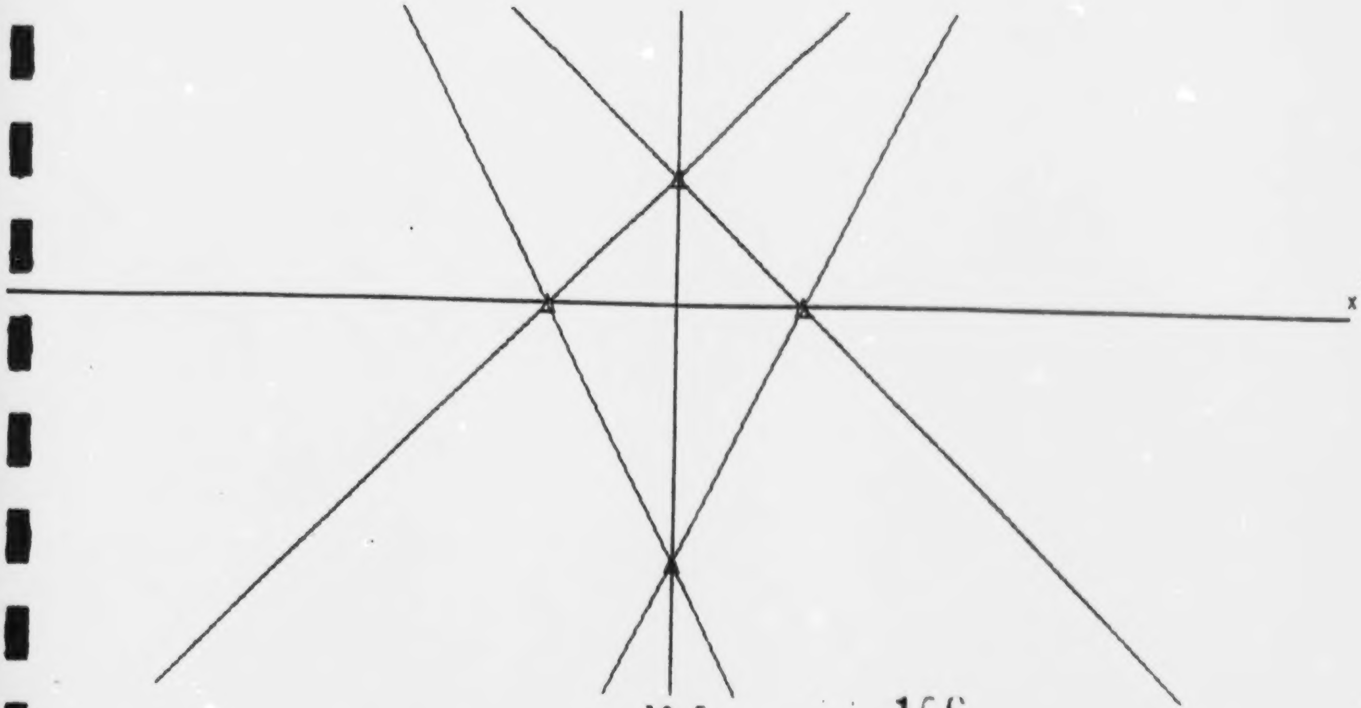
Select **5> POINT** in second level menu

PICK POINT WITH CURSOR appears in lower left corner

Repeat Single Using Y-Symmetry

(Imagine the vertical as a hinge)





Pick points

Select **6> LINE**

PICK LINE WITH CURSOR appears in lower left corner

Pick lines

The part you have created on the right side of the vertical will now appear symmetric on the left side of the vertical.

Note: ***In X-Symmetry the horizontal becomes the hinge line***

Note: ***Repeat all, transfers each group of elements, points, lines and circles***

Repeat Single Using Scaling

(Single Equals One Element Of The Geometry)
- Point, Line, or Circle

Select 2> **GEOMETRY** (draw your part)

*See the example on the next page.

Select 1> **MODE**

Select 7> **REPEAT SINGLE**

Select 2> **TRANSF**

Select 3> **SCALING**

Select 3> **TRANS CENTER**

Select 1> **X CENTER**

Type 5

ENTER
RETURN

Select 2> **Y CENTER**

Type 0

ENTER
RETURN

Select 4> **PARAMETERS**

Select 1> **# OF COPIES**

Type 1

ENTER
RETURN

Select 2> **FACTOR**

Type .5

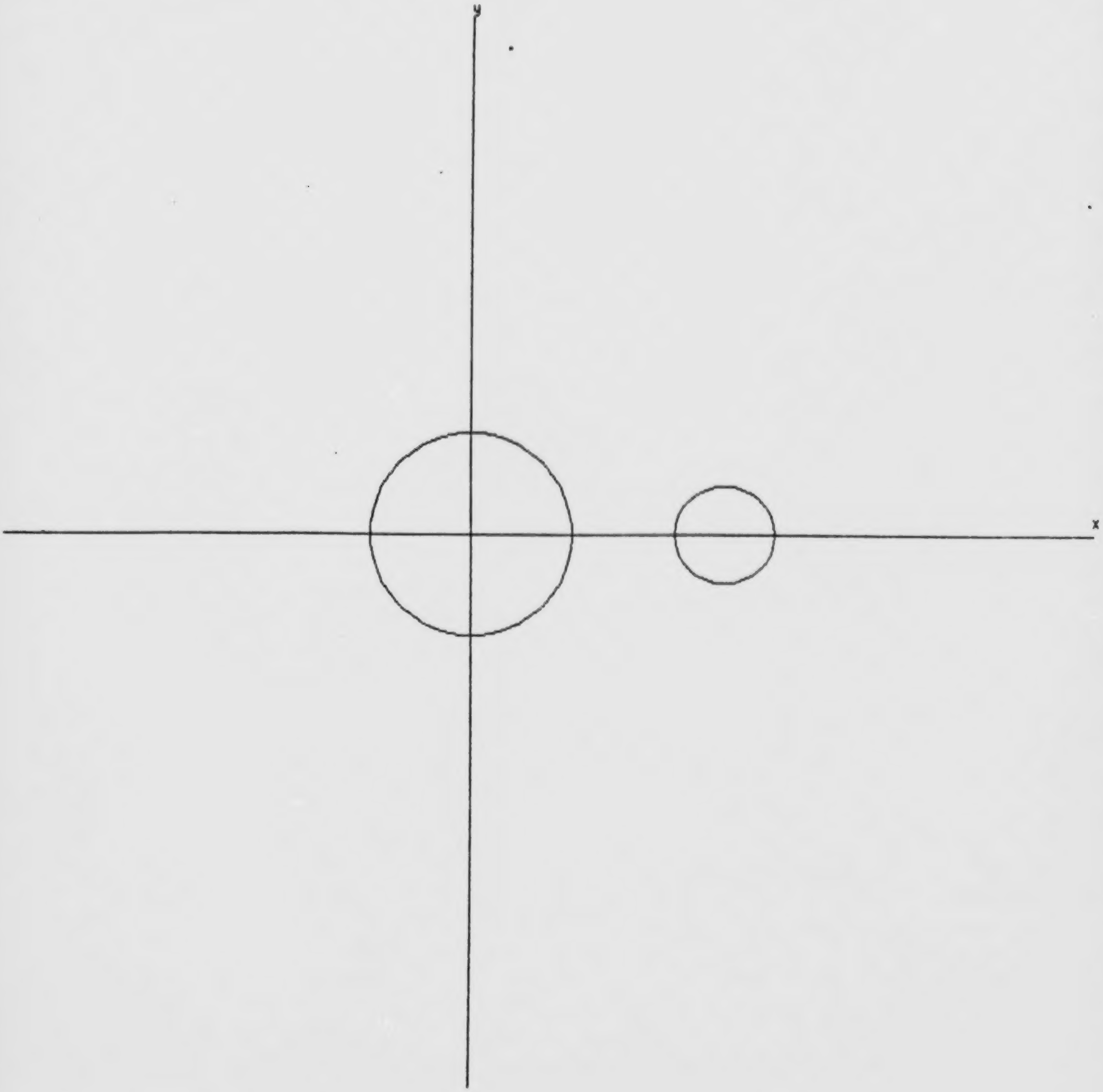
Select 7> **CIRCLE**

Pick circle with cursor

ENTER
RETURN

Note: ***A scale factor of .5 will generate geometry of one half the original size for the first copy. It will also cut the X and Y center factor by one half for each copy.***

Repeat Single Using Scaling



Repeat Single Using Rotation

Select 2> **GEOMETRY** (draw your part)

*See the example on the next page.

Select 1> **MODE**

Select 1> **DEFINE**

Select 4> **CIRCLE**

Select 2> **CENTER COORD**

Radius is asked for

Type .5

ENTER RETURN

Center X is asked for

Type 3.5

ENTER RETURN

Center Y is asked for

Type 0

ENTER RETURN

Select 1> **MODE**

Select 7> **REPEAT SINGLE**

Select 2> **TRANSF** (TRANSFORMATION) from second level menu

Select 1> **ROTATION** from third level menu

Select 3> **TRANS CENTER**

Type 0 for 1> **X CENTER**

ENTER RETURN

Type 0 for 2> **Y CENTER**

ENTER RETURN

Select 4> **PARAMETERS**

Select **1> # OF COPIES**

Type 3

ENTER
RETURN

Select **2> ANGLE**

Type 90

ENTER
RETURN

Select **7> CIRCLE**

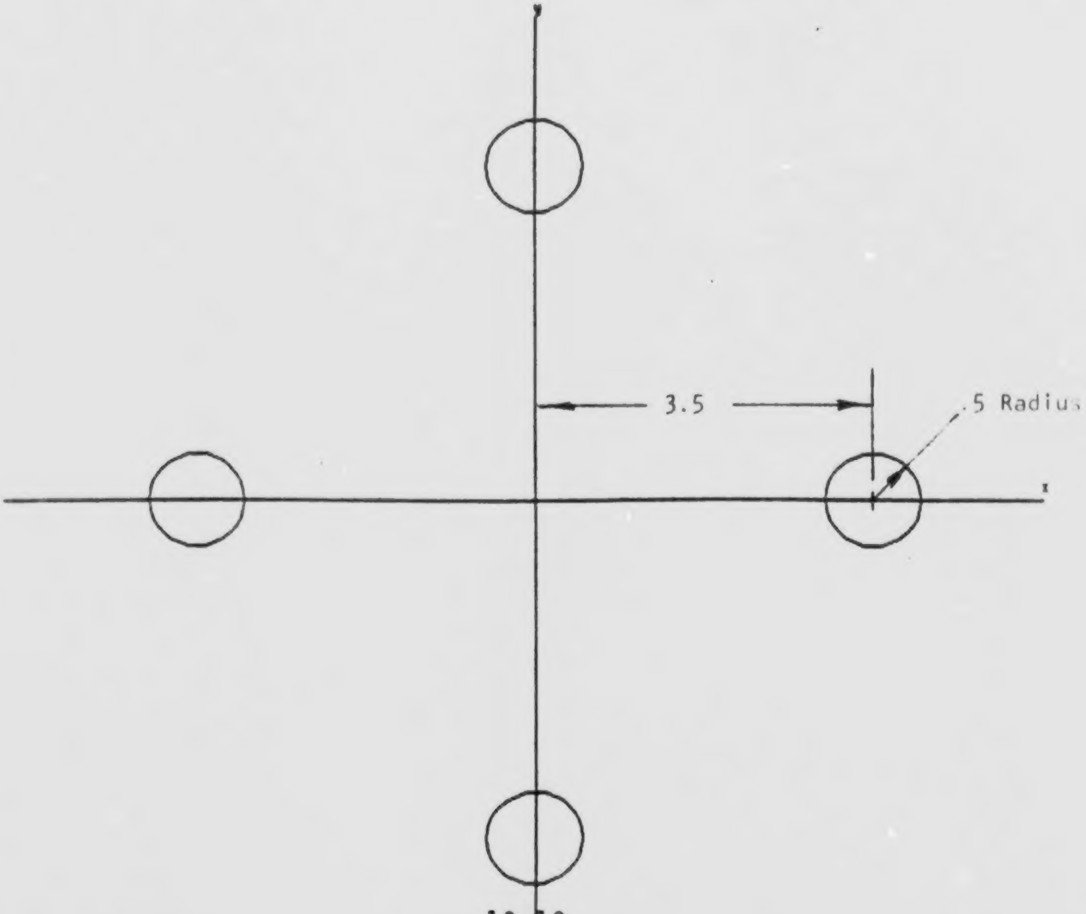
PICK CIRCLE WITH CURSOR appears in prompts and messages area

Pick circle with cursor and click mouse

Do you want to store new circles appears

In the prompts and messages area, select **Y** for Yes

Select **mode:** This will delete prompts and messages area



Notes:

APPENDIX 1

PREPARATORY FUNCTIONS (G CODES) USED IN MILLING

G-codes	
G00	Linear interpolation, Cartesian, rapid traverse
G01	Linear interpolation, Cartesian
G02	Circular interpolation, Cartesian, clockwise
G03	Circular interpolation, Cartesian, counterclockwise
G05	Circular interpolation, Cartesian, no direction specified
G06	Circular interpolation, Cartesian, tangential transition from previous contour
• G07	Paraxial positioning block
G10	Linear interpolation, polar, rapid traverse
G11	Linear interpolation, polar
G12	Circular interpolation, polar, clockwise
G13	Circular interpolation, polar, counterclockwise
G15	Circular interpolation, polar, no direction specified
G16	Circular interpolation, polar, tangential transition from previous contour
• G04	Dwell
G28	Mirror image
G36	Spindle orientation
G37	Pocket contour definition
• G39	Designates program, call via G79
G54	Datum shift
G56	Pre-drilling
G57	Roughing out
G58	Contour milling clockwise
G59	Contour milling counterclockwise
G72	Scaling factor
G73	Coordinate system rotation
G74	Slot milling
G75	Rectangular pocket milling clockwise
G76	Rectangular pocket milling counterclockwise
G77	Circular pocket milling clockwise
G78	Circular pocket milling counterclockwise
G83	Peck drilling
G84	Tapping
G17	Plane selection XY, tool axis Z
G18	Plane selection ZX, tool axis Y
G19	Plane selection YZ, tool axis X
G20	Tool axis = 4th axis

• G24	Chamfer with R
• G25	Corner rounding with R
• G26	Tangential contour approach with R
• G27	Tangential contour departure with R
• G29	Designate current position value as pole
G30	Blank workpiece definition for graphics: min. point
G31	Blank workpiece definition for graphics: max. point
• G38	Corresponds to STOP block in HEIDENHAIN format
G40	No tool compensation
G41	Tool path compensation, left of contour
G42	Tool path compensation, right of contour
• G43	Paraxial compensation, extension R+
• G44	Paraxial compensation, reduction R–
G50	Program protection (at start of program)
• G51	Next tool number (when using central tool memory)
• G55	Touch probe function with workpiece surface as datum plane
G70	Dimensions specified in inches (at start of program)
G71	Dimensions specified in millimetres (at start of program)
• G79	Call cycle
G90	Absolute dimensions
G91	Incremental dimensions
• G98	Set label number
• G99	Tool definition

• = Non-modal G-code

APPENDIX 2

MISCELLANEOUS (M) FUNCTIONS USED IN MILLING

M	Function	Active at block	
		beginning	end
M00	Stop program run/Spindle STOP/Coolant OFF		●
M02	Stop program run/Spindle STOP/Coolant OFF/if required: clearing the status display (indepedent of machine parameters)/Return to block 1		●
M03	Spindle ON: clockwise	●	
M04	Spindle ON: counterclockwise	●	
M05	Spindle STOP		●
M06	Tool change/Stop program run (if req'd., depends on specified machine parameters)/Spindle STOP		●
M08	Coolant ON	●	
M09	Coolant OFF		●
M13	Spindle ON: clockwise/Coolant ON	●	
M14	Spindle ON: counterclockwise/Coolant ON	●	
M30	same as M02		●
M89	Variable auxiliary function	●	
	- or -		
M89	Cycle call, modal (depends on machine parameters)		●
M90	Constant tool path feed rate at external and internal corners	●	
M91	**within positioning block:** coordinates refer to the reference point (Reference point substituted for workpiece datum)	●	
M92	**within positioning block:** coordinates refer to a position defined by machine manufacturer via machine parameter, e.g. tool change position (workpiece zero is replaced)	●	
M93	M-function assignment reserved by HEIDENHAIN	●	
M94	Reduction of displayed value for rotary table axis to below 360° (programmed setting of actual value)	●	
M95	Changed approach behavior for start in internal corners: no calculation of point of intersection		●
M96	Changed approach behavior for start at external corners: inserting a tangential circle		●
M97	Contour compensation on external corners: point of intersection instead of tangential circle		●
M98	End of contour compensation active blockwise: radius compensation RL/RR is cancelled only for the next positioning block		●
M99	Cycle call active blockwise		●

Address codes (ISO)

Address code	Function	Input range	
		Numbers	Parameter
%	Program start or call	0 - 99999999	–
A-axis	(rotation about X-axis)	± 30000.000	Q0 - Q99
B-axis	(rotation about Y-axis)	± 30000.000	Q0 - Q99
C-axis	(rotation about Z-axis)	± 30000.000	Q0 - Q99
D	Parameter definition (Program parameter Q)	0 - 14	–
F	Feed rate	0 - 15999	Q0 - Q99
F	Dwell with G04	0 - 19999.999	Q0 - Q99
F	Scaling factor with G72	0 - 99.999	–
G	G-code	0 - 99	–
H	Polar coordinate angle		
	in incremental dimensions	± 5400.000	Q0 - Q99
	in absolute dimensions	± 360.000	Q0 - Q99
H	Angle of rotation with G73	± 360.000	Q0 - Q99
I	X-coordinate of circle centre/pole	± 30000.000	Q0 - Q99
J	Y-coordinate of circle centre/pole	± 30000.000	Q0 - Q99
K	Z-coordinate of circle centre/pole	± 30000.000	Q0 - Q99
L	Set label number with G98	0 - 254	–
L	Jump to label number	1 - 254.65535	–
L	Tool length with G99	± 30000.000	Q0 - Q99
M	Auxiliary functions	0 - 99	–
N	Block number	1 - 9999	–
	in "Transfer blockwise" mode	1 - 65534	–
P	Cycle parameter in machining cycles	01 - 12	–
P	Parameter in parameter definitions	01 - 03	–
Q	Program parameter "Q"	0 - 99	–
R	Polar coordinate radius	± 30000.000	Q0 - Q99
R	Circle radius with G02/G03/G05	± 30000.000	Q0 - Q99
R	Rounding-off radius with G25/G26/G27	0 - 19999.999	Q0 - Q99
R	Chamfer length with G24	0 - 19999.999	Q0 - Q99
R	Tool radius with G99	± 30000.000	Q0 - Q99
S	Spindle speed	0 - 30000.000	–
S	Angular spindle position with G36	0 - 360.000	–
T	Tool definition with G99	0 - 254	–
T	Tool call	0 - 254	–
U-axis	(linear movement parallel to X-axis)	± 30000.000	Q0 - Q99
V-axis	(linear movement parallel to Y-axis)	± 30000.000	Q0 - Q99
W-axis	(linear movement parallel to Z-axis)	± 30000.000	Q0 - Q99
X	X-axis	± 30000.000	Q0 - Q99
Y	Y-axis	± 30000.000	Q0 - Q99
Z	Z-axis	± 30000.000	Q0 - Q99
*	End of block	–	–

APPENDIX 4

TO ABORT DURING MACHINING:

Press **SMALLER** red button ○

Press STOP

Press ✋ (MANUAL OPERATION)

Press STOP . This lets you enter an "M" word (M-25)= spindle stop and retract.

Enter 25

Press ENT

Press green button. ⏽

APPENDIX 5

To Restart After Abort During Program Run

Press ✋

Press STOP

Type 03 for spindle on C.W.

Press ⏽ , green button

Press ⇥ , program run full sequence

Press ⏽ , green button

APPENDIX 6

To Change Machine Language From Dialog To ISO

Press MOD

Use arrow keys ↑ ↓ to scroll to USER PARAMETERS or keep pressing the MOD key.

Press ENT

Use arrow keys ↑ ↓ to toggle to (dialog = 0, ISO = 1) 0 .

Note: *We are in dialog because of the 0 display at the right.*

Press 1 on the key pad for ISO

Press ENT

Press MOD

Note: *Machine shuts down in order to make this change.*

POWER INTERRUPTED appears at the top of your screen.

Press CE

Because we are now in ISO (G-Code Format), install the snap-on keyboard.

Reverse this procedure in order to change from ISO to Dialog.

APPENDIX 7

To Copy INT1 To Your Disk

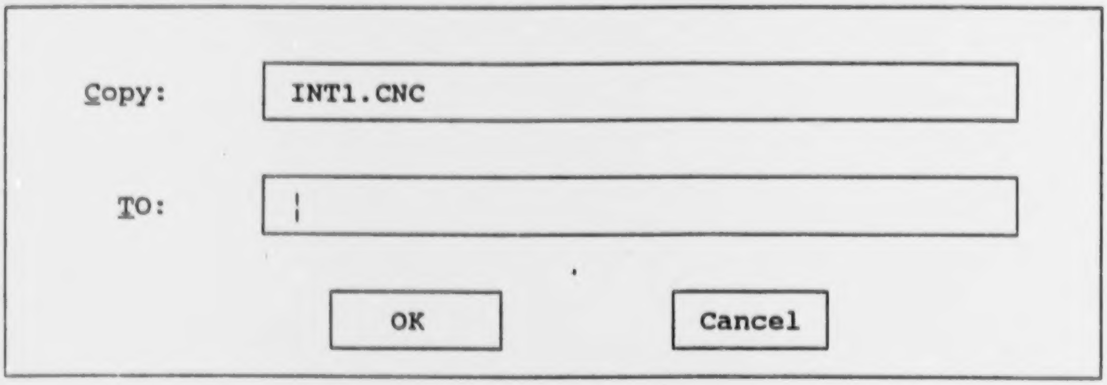
Select the C ▬ in windows.

Select INT1.CNC

Select file at the top left of the windows screen.

Select copy from the secondary menu that is displayed.

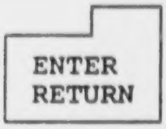
The screen will now look like the illustration below:



Copy: INT1.CNC

TO:

Type either A: or B: depending on which drive you want it copied to.



APPENDIX 8

To Clear Unwanted Material At Bridgeport

Press ⇨ (PROGRAMMING AND EDITING)

Press PGM NR

Press CL PGM

Highlight the program you want to clear with arrow keys or enter number on keypad.

When program is highlighted, press ENT

APPENDIX 9

Flashing At Top Of Screen:

```
AXIS 4 MEAS. SYSTEM DEFECTIVE A
```

Turn off main power switch on the side of the machine.

Important: When **POWER INTERRUPTED** is displayed on the top of the screen, do not press CE

Press MOD at lower right corner.

Continue pressing in order to scroll to USER PARAMETERS, or use the arrow keys, ↑ ↓

Press ENT

Illustration below will appear on screen.

```
POWER INTERRUPTED

XYZB=0    XYZ=8        o
```

Press 8 (for three axis)

Press ENT

Note: *The small o at the right (which means four axis) in the above illustration, has now been changed to an 8 (three axis). This machine will only operate in three axis.*

Press MOD , lower right.

APPENDIX 10

To Check Files on Your Disk
(or Access an Individual File)

Select **4> DISK** from top menu

Select **1> DIR** from second level menu

ENTER NAME appear at lower left

Type either A:\ or B:\ depending on which drive you are using

Press ENTER
RETURN

Select **2> LIST DIRECTORY**

Select FILES at bottom right on screen

At this time, the total contents of your disk will appear on the screen.

To access an individual file:

Select **3> PART NAME**

ENTER NAME appears at lower left

Type file name desired

Press ENTER
RETURN

Select **5> LOAD**

Select **2> GEOMETRY** from third level menu

GEOMETRY LOADED appears at lower left

Select Geom from concurrent commands

Your geometry will appear on the screen

Select **1> PART PROGRAM**

Select <All> (blue) at lower right

PART PROGRAM LOADED appears at lower left

Select Evry from concurrent commands

To Erase A Bad Program On Your Disk While You're In Windows

Select win and sel A-drive

Select prg. no. and click (gets black)

Select file

Select delete

If confirmed by you (visual), select O.K.

If You Want A Print Out Of A File While In Windows:

Select program from window listing

Select file (only TXT file)

Select print

Confirm visually and activate.

To Rename A File While In Windows

Pick file

Select file

Select rename

Retype new name

Select enter

APPENDIX 12

To Check All Tool Paths In EZ-EDM

Select part program.

Select verify.

Select motion record.

Select all moves.

Select continue and keep clicking for each move - watch screen.

To Move To A New Hole For More EDM Work
(At The Wire EDM)

Break wire

Hit dry run

Machine will move to location for hole

To Provide An Optional Stop For Magnet Placement During Path Making In EZ-EDM

Select part program.

Select create path.

Select define.

Select next move like, "C.W."

Select suffix

Lower left says enter string

Type M 02

Select ENT , & M 02 will show at suffix.

Notes:

EZ-EDM PROGRAMMING

Introduction:

A. Disk Care

1. Do not touch disk surface
2. Do not bend or distort
3. Keep clean
4. Use felt-tip pen for labeling
5. Keep away from magnetic sources
6. Store disk vertically

B. Routine Care

1. Make sure area is clean
2. Beverages and food are not allowed near computers
3. If you plan to leave the system on for long periods of time, remember to turn the screen brightness down or it could damage the screen
4. Do not drop the mouse or let it hang from its cable
5. Use the mouse on a clean, dust-free surface

C. Hardware Start-Up

1. Turn on computer terminal at right rear on cabinet.
2. Turn on all peripheral equipment.
3. Reverse procedure for shut down.

Objectives:

Upon successful completion of this unit, the student will:

1. Be familiar with disks
2. Be familiar with hardware start-up
3. Have an awareness of proper hardware and software care.

Materials Required For EZ-EDM Programming

1. Either a 3 1/2" or 5 1/4" disk. It must be double-sided, high-density.
2. Access to an IBM Compatable computer with EZ-CAM software loaded.
3. EZ-EDM User's Manual

Start Up Procedure For EZ-EDM

Turn on the main electrical switch, , which will usually activate the monitor, keyboard, computer, and printer. If the monitor doesn't light up, press the switch on the monitor. Make sure the keyboard is on by pressing

NUM
LOCK .

The key will light up and the "upper case numbers" under the key will be available for programming, providing the keyboard is on. The computer has a switch on the back that can be used if the green light doesn't show at the front. You can also hear the computer run if it is on. The printer will light up if it is on. If it isn't, use the switch on the side of the printer. The on line off line button will enable you to print information by pressing it until the light next to "on line" shows. If the light is off, you will be able to move the paper one line at a time with the

Draft Line Feed AutoLoad button.

You can move the paper one sheet at a time by pressing the

NLQ ROMAN SANS SERIF FORM FEED button.

You can also roll the paper by hand with the hand roller located on the right side of the printer (only when the printer is turned off). Position the paper perforation slightly above the feed sprockets.

To Format A Disk

Introduction:

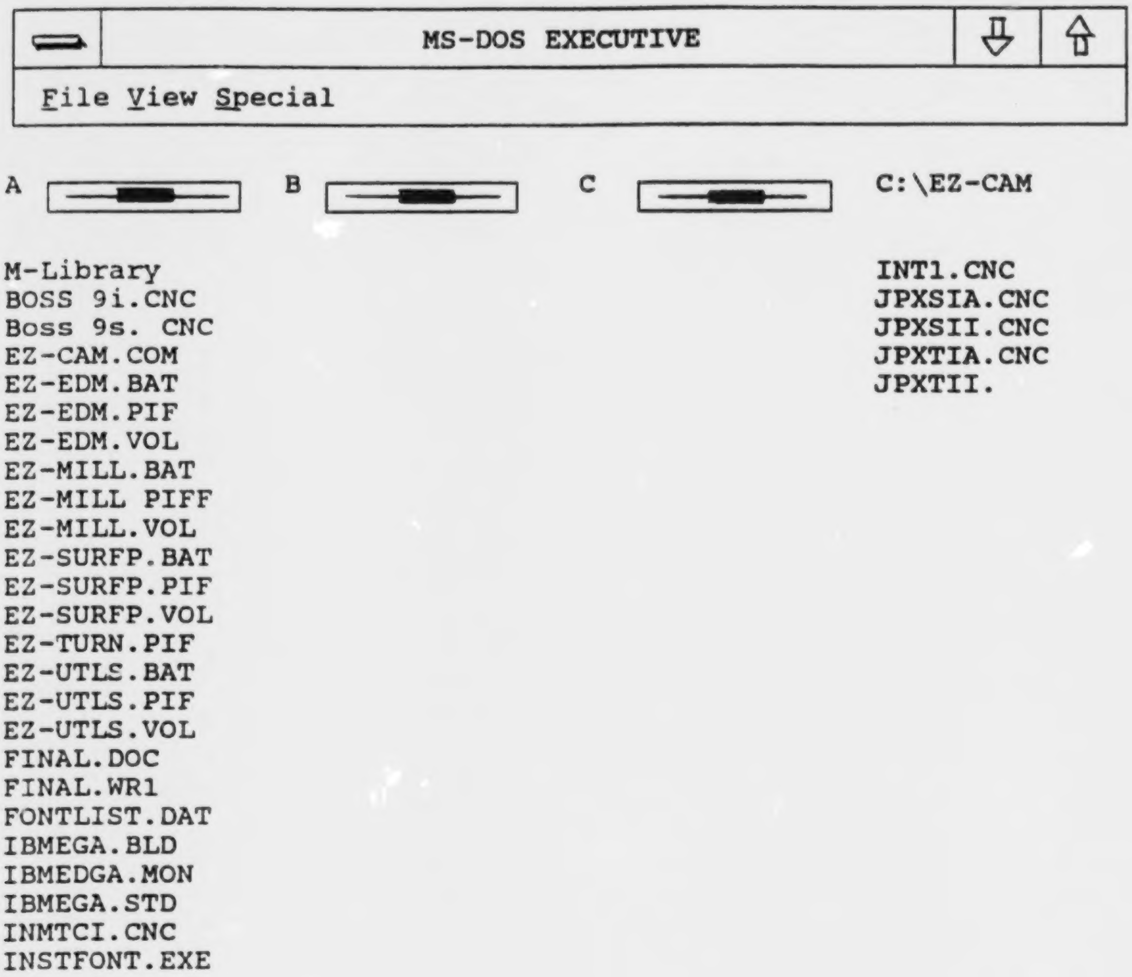
The disk must be formatted in order to accept (store or save) programmed information. During the formatting, the disk is divided into approximately 80 multiple segments.

Objectives:

1. Upon successful completion of this unit, the student will be able to format a disk.

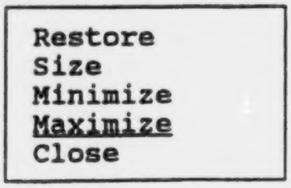
2. The student will understand what happened to the disk during formatting.

A menu of the hard drive (C) will appear as below. The total software loaded in the C drive can vary from that pictured below.



```
MS-DOS EXECUTIVE
File View Special

A            B            C            C:\EZ-CAM

M-Library                              INT1.CNC
BOSS 9i.CNC                            JPXSIA.CNC
Boss 9s. CNC                           JPXSII.CNC
EZ-CAM.COM                             JPXTIA.CNC
EZ-EDM.BAT                             JPXTII.
EZ-EDM.PIF
EZ-EDM.VOL
EZ-MILL.BAT
EZ-MILL PIFF
EZ-MILL.VOL
EZ-SURFP.BAT
EZ-SURFP.PIF
EZ-SURFP.VOL
EZ-TURN.PIF
EZ-UTLS.BAT
EZ-UTLS.PIF
EZ-UTLS.VOL
FINAL.DOC
FINAL.WR1
FONTLIST.DAT
IBMEGA.BLD
IBMEDGA.MON
IBMEGA.STD
INMTCI.CNC
INSTFONT.EXE
```

To Format: If the "MS DOS Executive" picture (shown above) comes up and we haven't formatted a disk, click on the upper left corner " ▭ " and a small blue box will appear at the upper left. Click on "close."



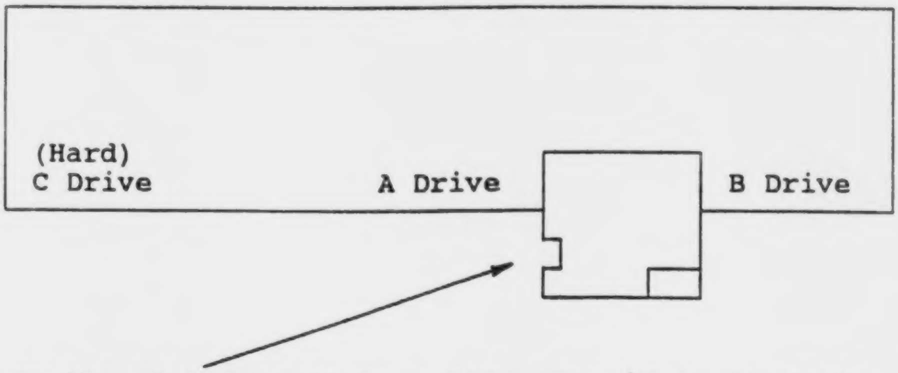
Restore
Size
Minimize
Maximize
Close

"End Session" will come up. Click on "OK" and the "Tool and Die Software" menu will come up.

```
EZ, EZ-CAM
Tutor, Tutor - Word Perfect
WP, Word Perfect (Version 4.2)
FA, Format a blank disk in drive A: (1.2 M)
Ship, Park Hard Drive for Moving


Please select letter code and enter
```

Formatting the disk will prepare it for use with our software called "EZ-CAM".

Type F A and press ENTER RETURN . The bottom of the screen will say, "Insert new disk in drive A: and press ENTER RETURN when ready." The disk must go in as pictured.



Make sure the slot doesn't have tape over it or it won't accept a format. The slot is usually taped if it has information on it that must not be erased. Insert the disk, flip the lock lever down, and hit the key labeled,

ENTER RETURN

You can watch the bottom of the screen while the format is happening. It will start at:

```
HEAD: 0    CYLINDER: 0
      1
```

and will end at:

```
HEAD: 0    CYLINDER: 79
      1
```

This takes approximately "79" seconds. The bottom of the screen will say, "Do you want to format another disk? (Y or N)". Type N and ENTER RETURN. The "Tool and Die Software Menu" will appear and we are now ready to enter EZ-CAM.

```
EZ, EZ-CAM
Tutor, Tutor - Word Perfect
WP, Word Perfect (Version 4.2)
FA, Format a blank disk in drive A: (1.2 M)
Ship, Park Hard Drive for Moving

Please select letter code and enter
```

Type E Z and press ENTER RETURN. We are now in "windows." The top of the screen will say, "MS DOS Executive." "Windows" is an area in the computer that will display all the software packages that are available to us. The two software packages that we will work with are called "EZ-EDM.BAT" and "EZ-MILL.BAT". You are going to wire EDM a die which means you will want to use the "EZ-EDM.BAT" software.

Notes:

INTRODUCTION TO EZ-EDM.BAT USING
SIMPLIFIED INTERACTIVE PART PROGRAMMING

Introduction

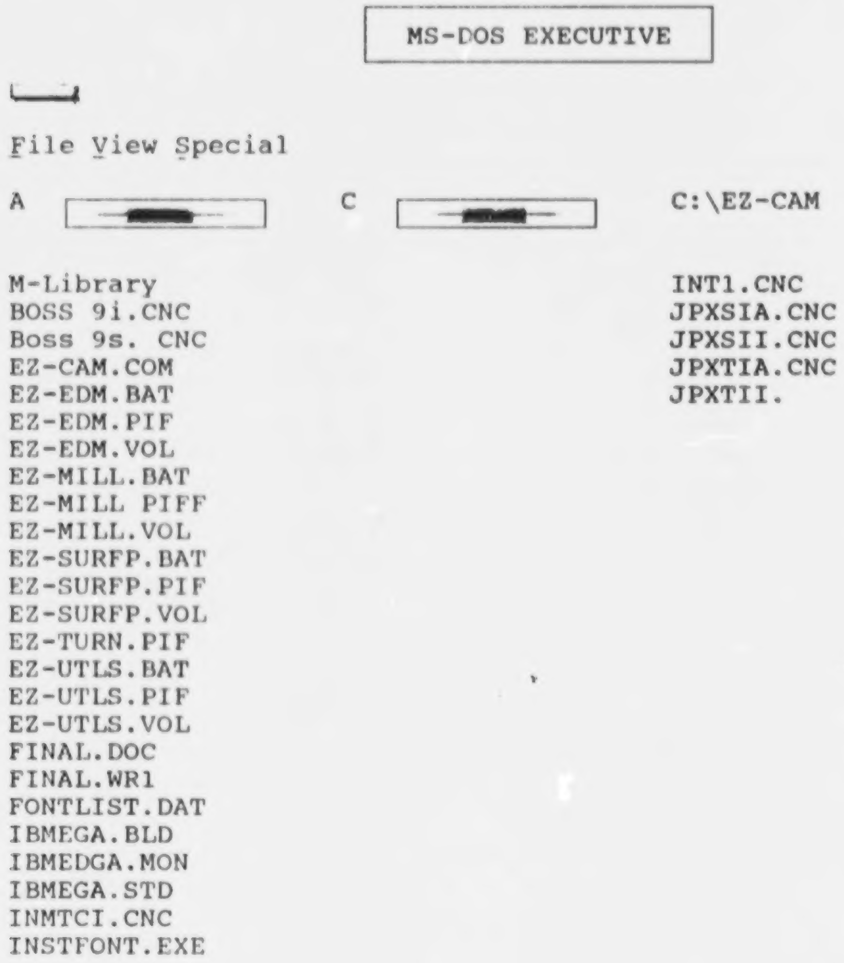
The first step to a complete understanding of EZ-EDM is to familiarize yourself with the basic setup procedure using SIPP, Setup, Set Windows, Axis, and Geometry.

In this unit, we will discuss quadrants, window size, screen layout, and line definitions.

Objectives

Upon successful completion of this unit, the student will:

1. Be able to access windows and EZ-EDM.BAT.
2. Be able to access and use Simplified Interactive Part Programming (SIPP).
3. Be able to access Setup in the top menu and Set Windows in the second level menu.
4. Be able to access the Axis command and understand the four quadrants.
5. Be knowledgeable in the ten areas used in the screen layout.
6. Be able to calculate, set, and store the new window size.
7. Be able to access geometry in the top menu.
8. Be able to define lines using parallel X and Y axis.

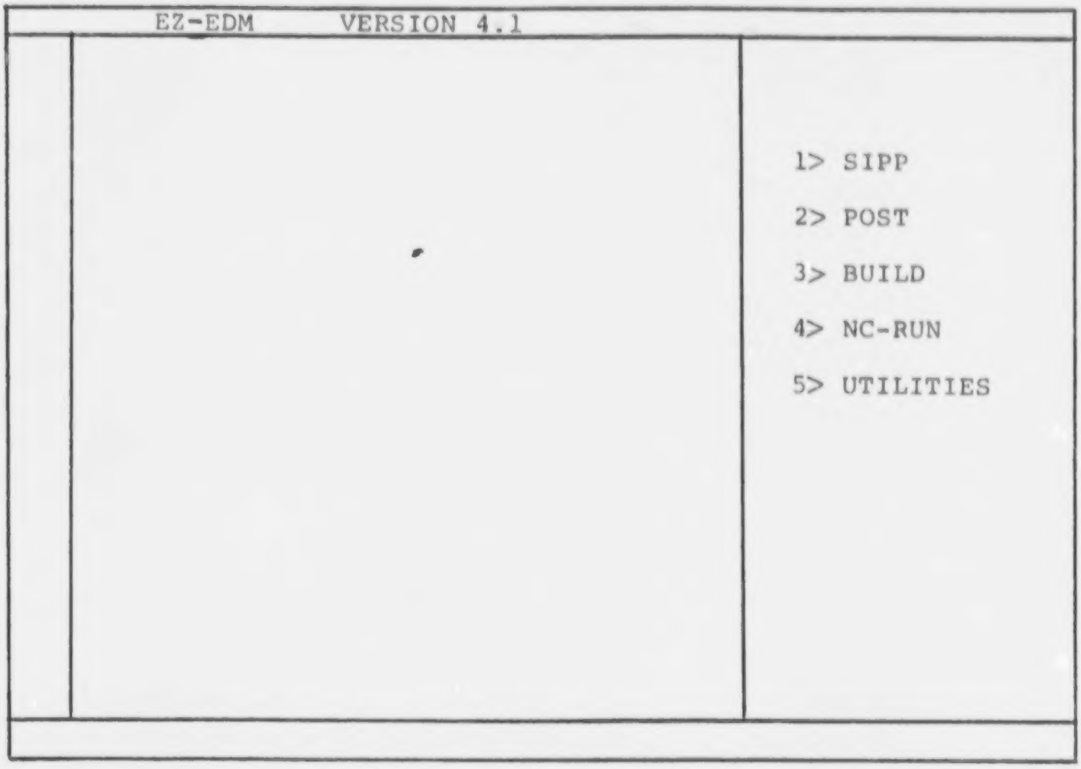


```
                    MS-DOS EXECUTIVE

File View Special

A                     C                      C:\EZ-CAM

M-Library                                    INT1.CNC
BOSS 9i.CNC                                  JPXSIA.CNC
Boss 9s. CNC                                 JPXSII.CNC
EZ-CAM.COM                                   JPXTIA.CNC
EZ-EDM.BAT                                   JPXTII.
EZ-EDM.PIF
EZ-EDM.VOL
EZ-MILL.BAT
EZ-MILL PIFF
EZ-MILL.VOL
EZ-SURFP.BAT
EZ-SURFP.PIF
EZ-SURFP.VOL
EZ-TURN.PIF
EZ-UTLS.BAT
EZ-UTLS.PIF
EZ-UTLS.VOL
FINAL.DOC
FINAL.WR1
FONTLIST.DAT
IBMEGA.BLD
IBMEDGA.MON
IBMEGA.STD
INMTCI.CNC
INSTFONT.EXE
```

Select: **"EZ-EDM.BAT"** with the left button of the mouse. Click twice quickly or it won't take. You can also use the arrow keys on the right of the keyboard to highlight your menu choice. This would then require your pressing the ENTER RETURN key.

A third choice would be to highlight your choice with the mouse and then press ENTER RETURN.

The hour glass " ⌛ " will appear if done properly. The top of the screen will change to "EZ-EDM Version 4.1". From the five choices that come up on the screen,



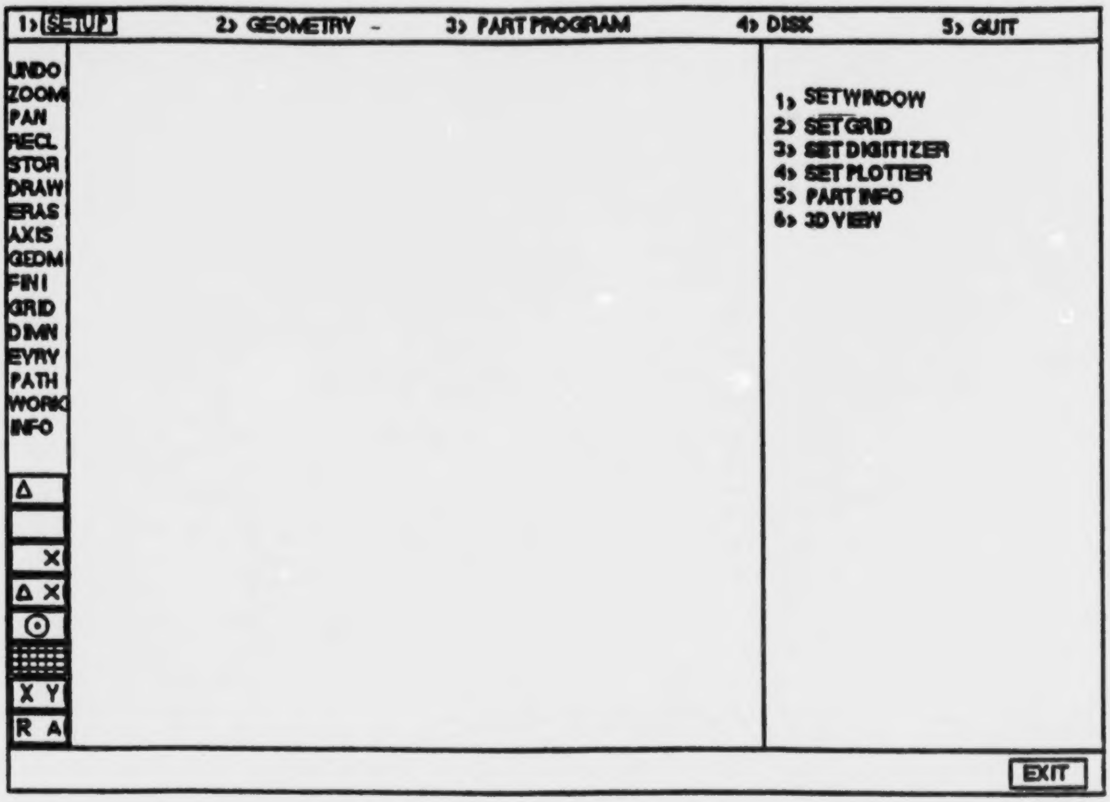
EZ-EDM VERSION 4.1

1> SIPP
2> POST
3> BUILD
4> NC-RUN
5> UTILITIES

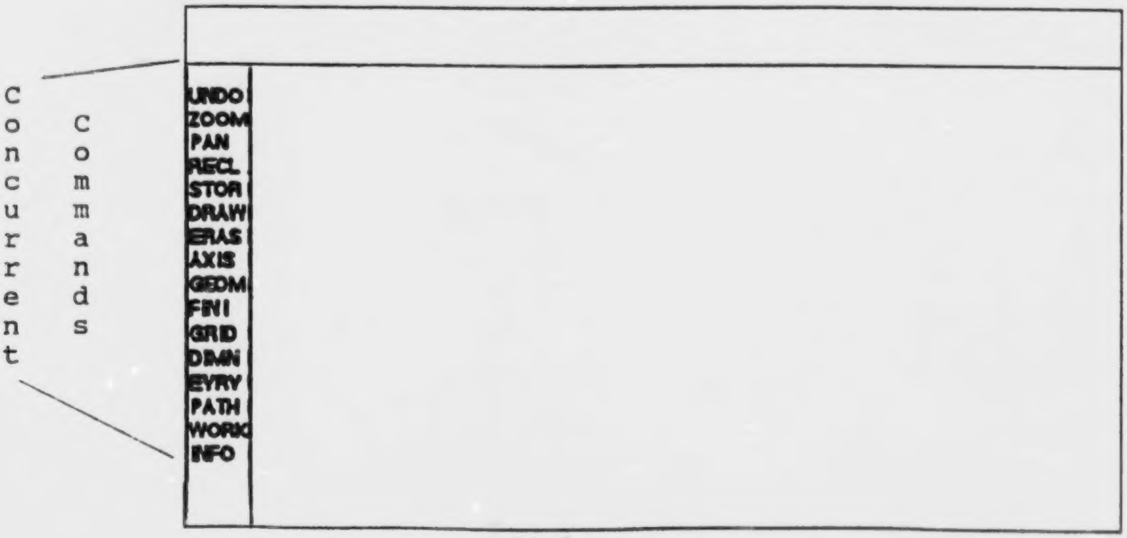
Select Number **1> SIPP**, by moving the cursor to SIPP and clicking the mouse. (SIPP is an abbreviation for Simplified Interactive Part Programming)

You can use any button on the mouse now if you want to. We only use the left button when we are "in windows." Select **1> SET UP** from the screen below. Use your mouse.

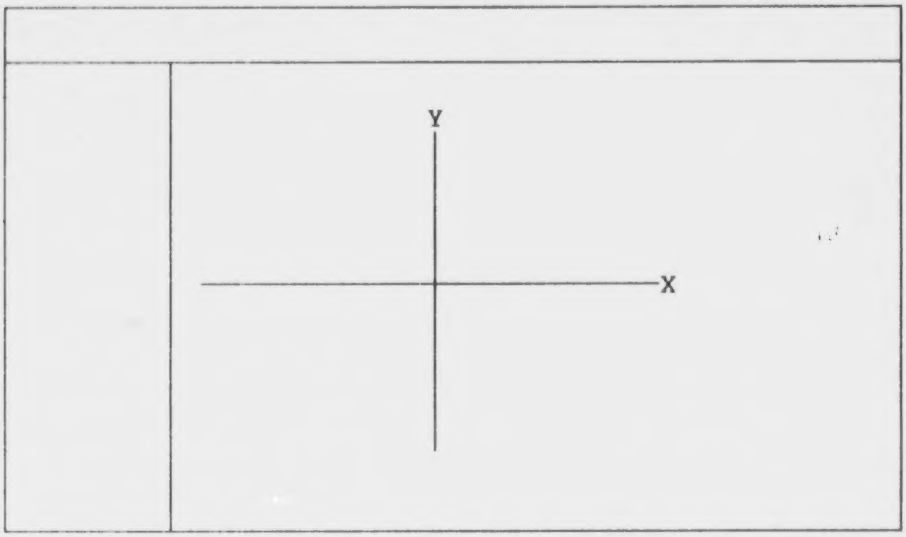
1> SET UP will get boxed in blue and the screen will appear as below.


1> SETUP
2> GEOMETRY -
3> PART PROGRAM
4> DISK
5> QUIT
UNDO
ZOOM
PAN
RECL
STOR
DRAW
ERAS
AXIS
GEOM
FINI
GRID
DIMN
EVRY
PATH
WORK
INFO
Δ
X
Δ X
X Y
R A
1> SETWINDOW
2> SETGRID
3> SET DIGITIZER
4> SET PLOTTER
5> PART INFO
6> 3D VIEW
EXIT

Select: **AXIS** from the "Concurrent Commands" on the left side of the screen or press "A" on keyboard. Either method will toggle the axis on-off.


Concurrent Commands
UNDO
ZOOM
PAN
RECL
STOR
DRAW
ERAS
AXIS
GEOM
FINI
GRID
DIMN
EVRY
PATH
WORK
INFO

The axis will come up centered on the screen as shown below.

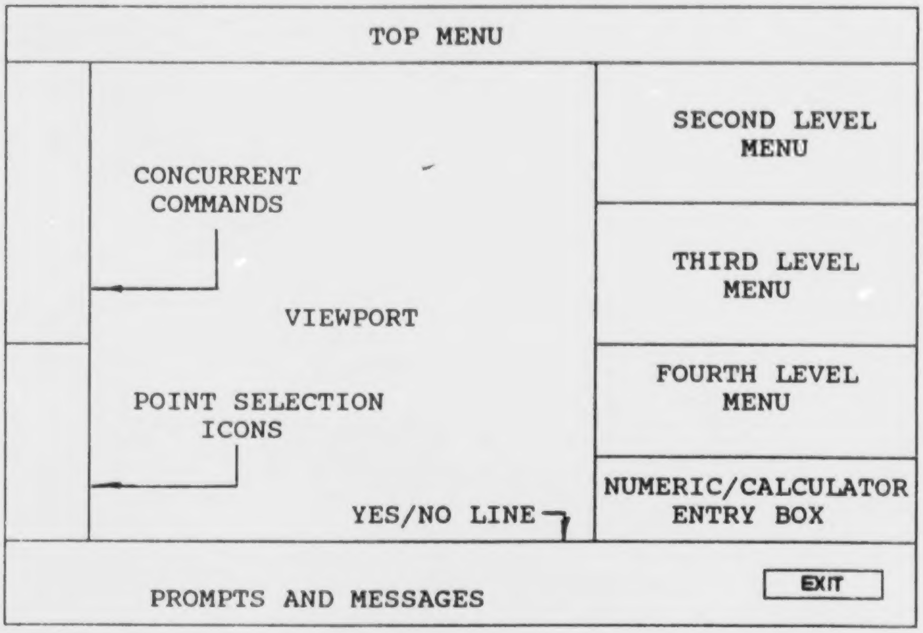


Four quadrants are shown above and we can work in all four at once or we could pick one to work in. Your part print will usually dictate how you should set the "window" which is going to be your area for the drawing, called the "geometry." Many people like to work in the upper right (first) quadrant which would make the geometry all positive from the intersection of the X and Y axis. X and Y, of course, both equal zero at this point.

If we decide to work in the upper right quadrant, let's put the X and Y axis to the bottom and left sides of our screen. This will give us a larger window to work in. This means we will be moving the axis intersection to the lower left part of the screen.

Make sure the light shows on the NUM LOCK key. If it doesn't, just press the key. Again, this will enable us to use all the number keys below the NUM LOCK key. The number keys at the top of the key board are also available.

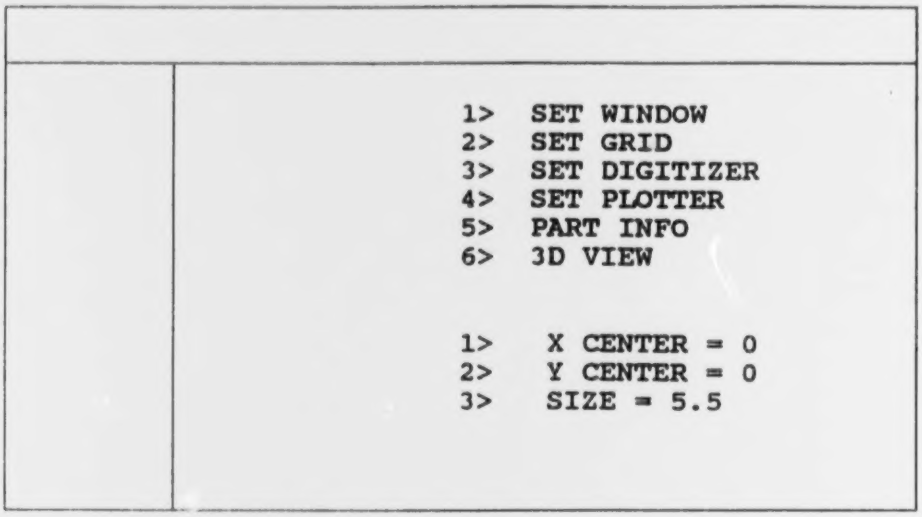
Don't forget to check all parts of your screen. The drawing below gives you the screen layout you will be working with.


TOP MENU
CONCURRENT COMMANDS
VIEWPORT
POINT SELECTION ICONS
YES/NO LINE
SECOND LEVEL MENU
THIRD LEVEL MENU
FOURTH LEVEL MENU
NUMERIC/CALCULATOR ENTRY BOX
PROMPTS AND MESSAGES
EXIT

See Chapter 3-2 in the User's Manual for more information.

Select "Set Window" with the mouse. The screen will appear as below.

Note: Use the mouse for your menu choices from now on.


1> SET WINDOW
2> SET GRID
3> SET DIGITIZER
4> SET PLOTTER
5> PART INFO
6> 3D VIEW

1> X CENTER = 0
2> Y CENTER = 0
3> SIZE = 5.5

Select: 1> **X CENTER**, it will be boxed. X Center = 0

Type: 1

Select: Enter , **1> X CENTER** = 1 appears

Select: 2> **Y CENTER**, it will be boxed. Y Center = 0

Type: 1

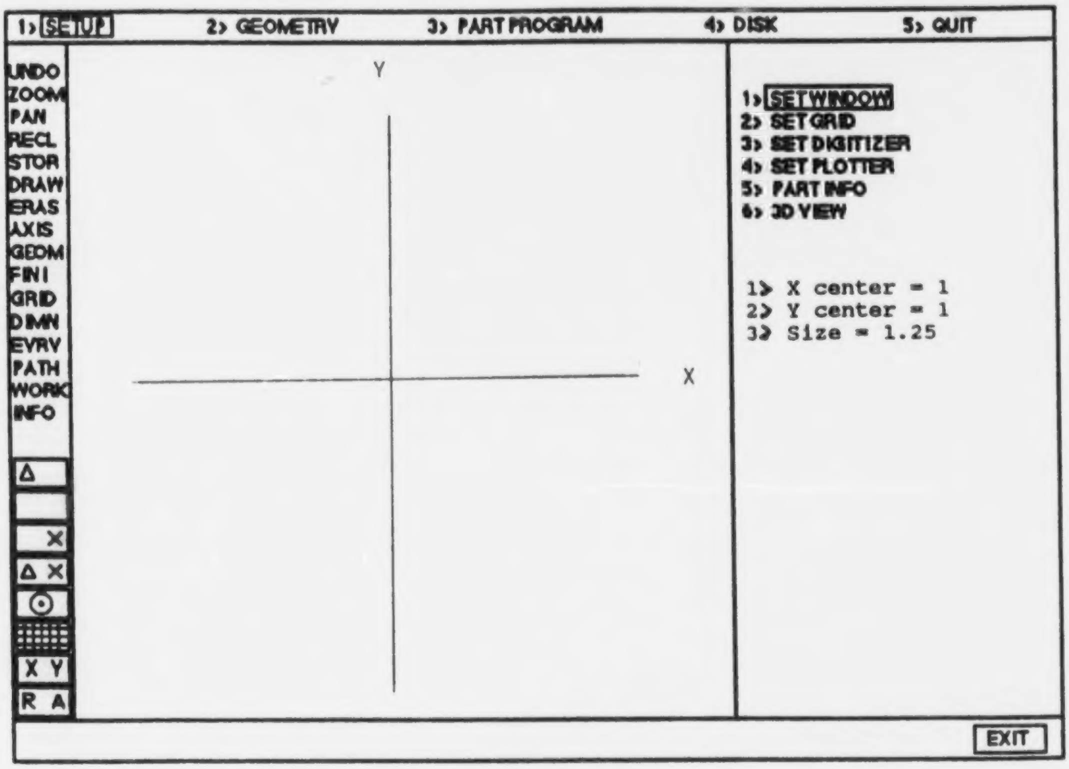
Select: Enter , **2> Y CENTER** = 1 appears

Select: 3> **SIZE**, it will be boxed. Size = 5.5

Type: 1.25

Select: Enter , **3> SIZE** = 1.25 appears

Your picture now appears as below:


1> SETUP
2> GEOMETRY
3> PART PROGRAM
4> DISK
5> QUIT
UNDO
ZOOM
PAN
RECL
STOR
DRAW
ERAS
AXIS
GEOM
FINI
GRID
DIMN
EVRY
PATH
WORK
INFO
Δ
X
Δ X
X Y
R A
Y
X
1> SET WINDOW
2> SET GRID
3> SET DIGITIZER
4> SET PLOTTER
5> PART INFO
6> 3D VIEW
EXIT

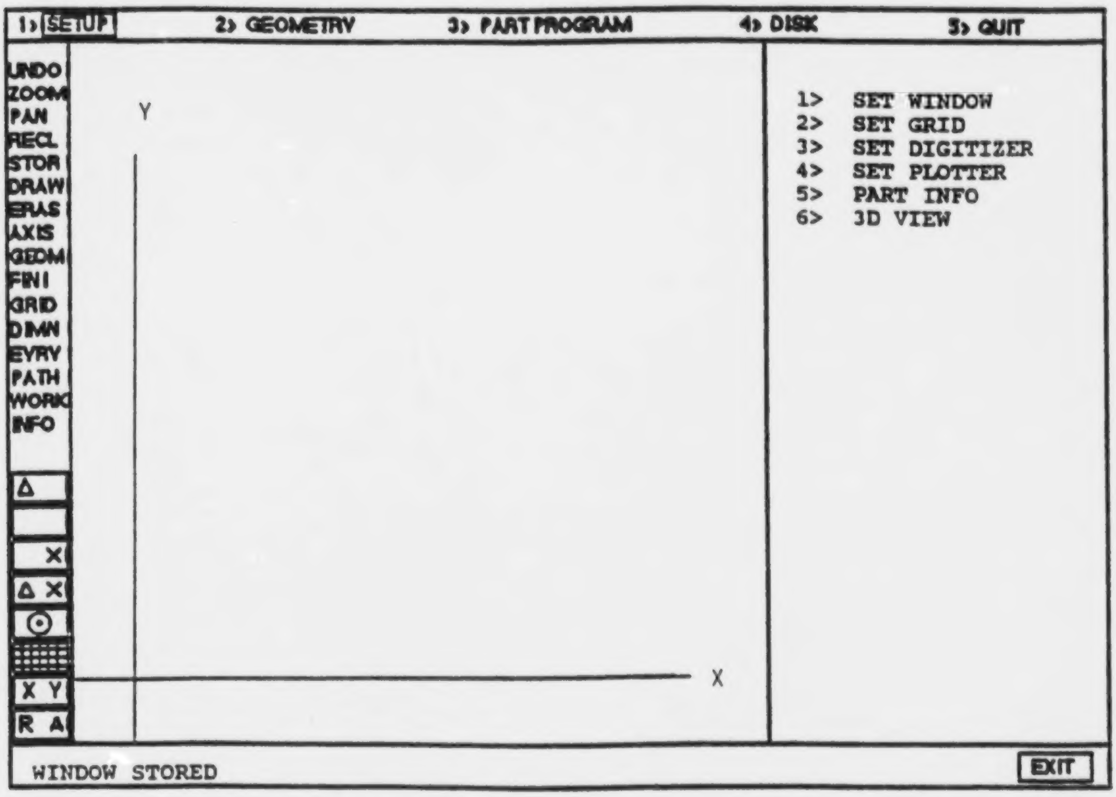
1> X center = 1
2> Y center = 1
3> Size = 1.25

Select: **EXIT**, lower right and the new axis will appear.

Select: **STOR**, from concurrent commands on left side of screen. "Change stored window" appears in the prompts and messages box. Click the mouse anywhere above the yes/no line, lower right $\frac{\text{Y}}{\text{N}}$. This signifies a yes.

WINDOW STORED appears at the lower left in the prompts and messages area.

Your screen will appear as below:


1> SETUP
2> GEOMETRY
3> PART PROGRAM
4> DISK
5> QUIT
UNDO
ZOOM
PAN
RECL
STOR
DRAW
ERAS
AXIS
GEOM
FINI
GRID
DIMN
EVRY
PATH
WORK
INFO
Δ
X
Δ X
X Y
R A
Y
X
1> SET WINDOW
2> SET GRID
3> SET DIGITIZER
4> SET PLOTTER
5> PART INFO
6> 3D VIEW
EXIT

WINDOW STORED

Just to prove what happens when you have set your new window size at these new values,

X Center = 1, Y Center = 1, Size = 1.25

Select: 2> **GEOMETRY** from top menu

Note: Make sure, mode = define; If not select mode and nine menu items will appear in the third level menu. Select define.

Select: 3> **LINE**

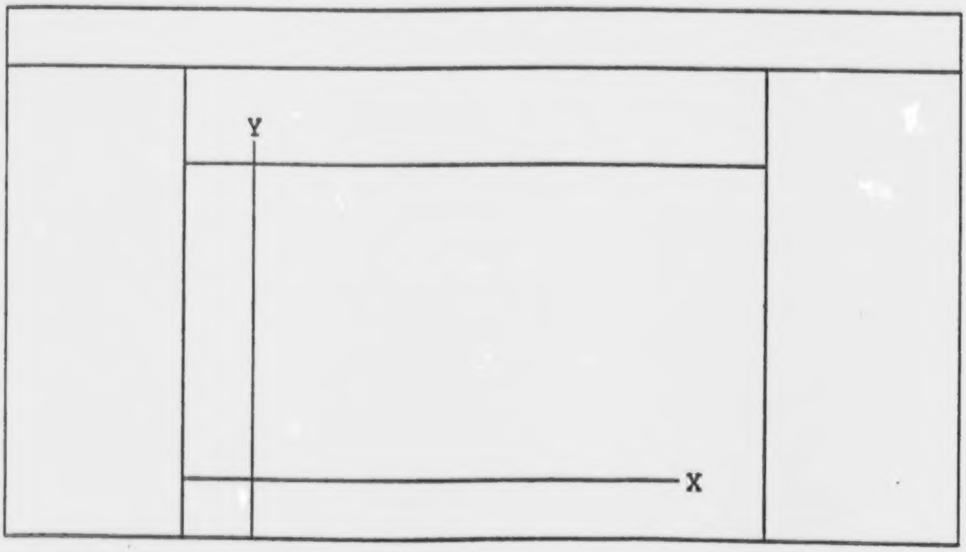
Select: 1> **PARALLEL X AXIS**

Offset valve <0.0> appears above the numeric/calculator entry box.

Type: 2

Press: ENTER RETURN , and a line appears parallel to the X axis

See below.



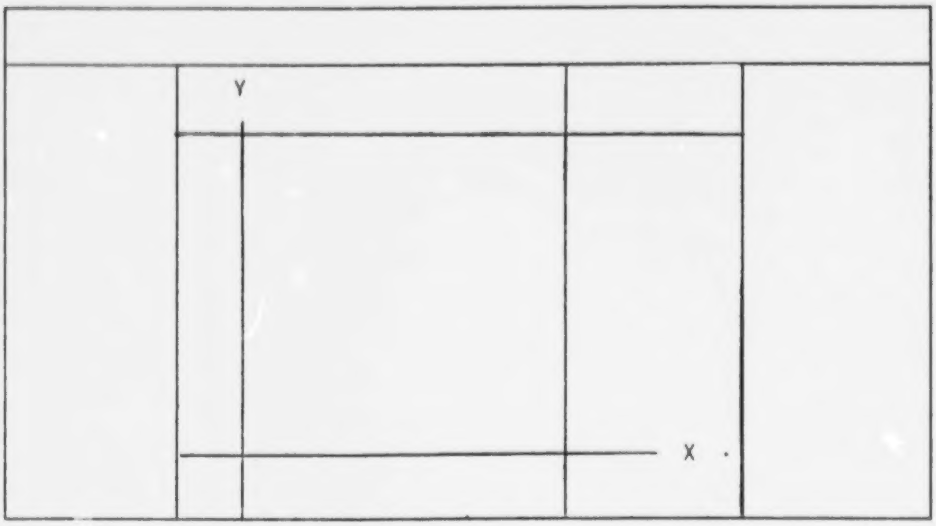
Select: 2> **PARALLEL Y AXIS**

The last entry value will appear above the numeric/calculator entry box.

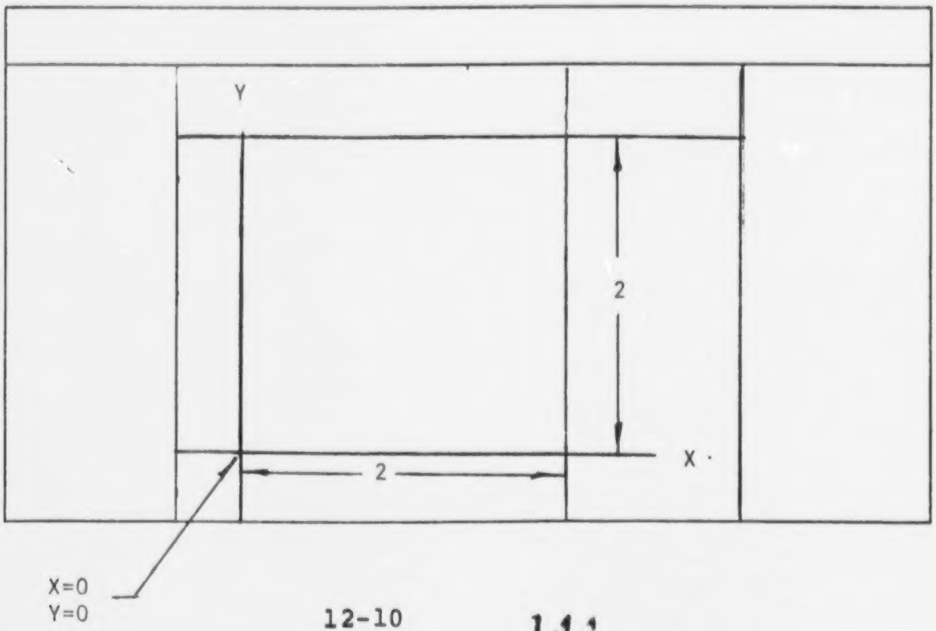
Type: 2

Press: ENTER RETURN , and a line appears parallel to the Y axis.

See below.



Note that the X=2, Y=2, both show up clearly as indicated on the following screen picture.



We picked 1.25 for the window size which means it is 1.25" from the center of the screen to the edge of the screen. We picked 2 for the horizontal line which means it is 2" from the X-axis. We picked 2 for the vertical line which means it is 2" from the Y-axis.

Select 1> PARAL X AXIS

Type 0

Press ENTER RETURN

Select 2> PARAL Y AXIS

Type 0

Press ENTER RETURN

Note: *Our axis lines now appear as green lines because they are part of our geometry.*

Just For Experience:

Select: 1> **SET UP** from the top menu

Select: 1> **SET WINDOW** from the second level menu

Select: 1> **X CENTER** from the third level menu

Type: 8

Press: ENTER RETURN

Select: **2> Y CENTER** from the third level menu

Type: 8

Press: ENTER RETURN

Select: **3> SIZE** from the third level menu

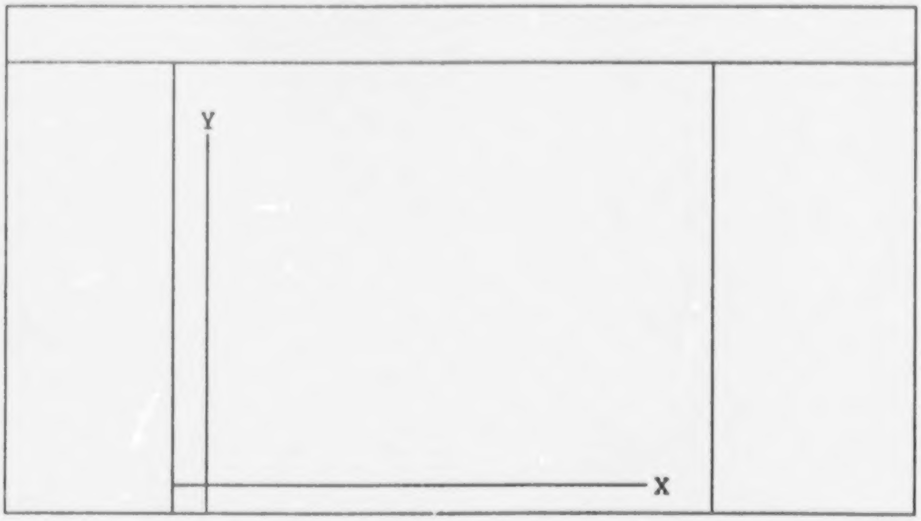
Type: 8

Press: ENTER RETURN

Note that all now equal eight.

1. X Center = 8
2. Y Center = 8
3. Size = 8

Select: EXIT Note new axis lines (X & Y) appear at edges of screen.



Select: **STOR** if you want to save this new axis. Bottom left of screen says, "Change stored window?"

Select: Y, by clicking above the **yes/no line.**

WINDOW STORED appears at the lower left.

The axis is now 8" from the center of the screen and the window center is 8" from the side of the screen.

If at this time you want to create new geometry:

Select **5> QUIT** from the top menu

Select **1> START OVER**

Confirm by typing Y for yes

This will clear your screen and allow you to start over.

Notes:

WIRE ELECTRICAL DISCHARGE MACHINING

Introduction

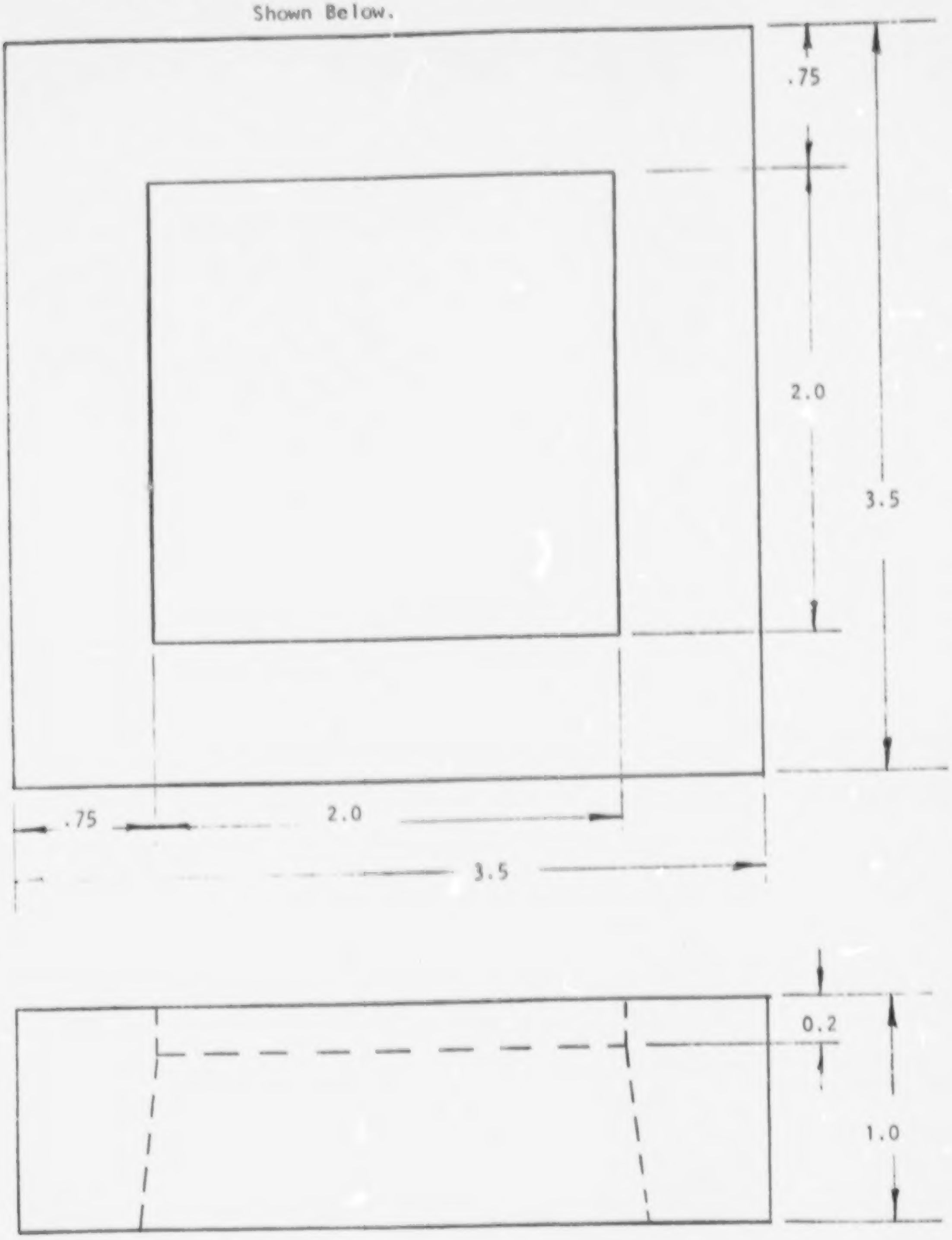
Wire EDM (Electrical Discharge Machining) is the process of removing metal with an electrical discharge from a small diameter traveling wire. The geometry, part program, set up, alignment and burning are all accomplished with the aid of a computer.

Objectives

Upon successful completion of this unit, the student will:

1. Be able to adjust the upper arm position and the table height.
2. Be able to determine the proper offset direction.
3. Be able to create the part path.
4. Be able to choose between normal linear or constant tapers.
5. Be able to create the proper wire comp for rough cutting.
6. Be able to cancel the wire taper and cut a straight land.
7. Be able to create the proper wire comp for finish cutting.
8. Be aware of the global change and taper as it pertains to motion record.

Create the Necessary Part Geometry For The Die
Shown Below.


.75
2.0
3.5
.75
2.0
3.5
0.2
1.0

THE PART PROGRAM FOR WIRE E.D.M.

Select 3> Part Program at top menu

SEGMENT ID appears at lower left on screen. Type desired segment name. For the first segment, use 1- (plus a name). This will enable you to recall that segment by calling up just the number.

Press ENTER RETURN

When **2> CYCLE** comes up, select **1> CONTOURING.**

Select **3> SEGM PARAMS**

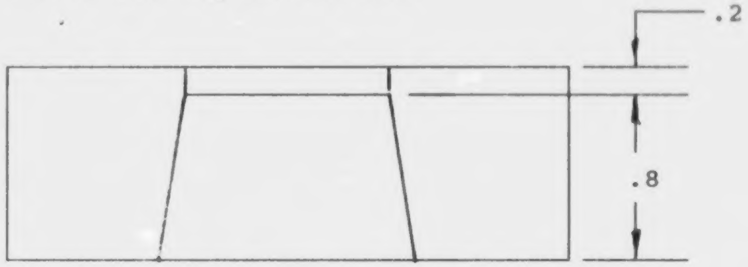
Select **1> POS & FEED**

Select **1> UPPER ARM POS.** Type in 25. This is millimeters for your 1" thick die. If your die is not 1" thick, use the proper mm setting on the upper arm of the machine.

Press ENTER RETURN

Select **2> AD TABLE HT**

Type .8 because we want the taper on the die surfaces that need it, to start .2 from the top of the die.



Press ENTER RETURN

Select **4> CYCLE DATA** from second level menu

Select **1> OFFSET DIR** toggle offset direction for right, not left.

Offset value stays at "0". It will be set when path is created.

Select **3> WIRE DIA.**

Type .010

Press ENTER RETURN

4> TABCYC TOL should be .005 (default). If it isn't .005, enter .005.

Creating The Part Path

Select **5> CREATE PATH**

Select **1> DEFINE** (or "copy" if you used taper cut first and then wanted to cut straight)

Select **2> LINEAR** or **5> ARC TANG**, but first move must be linear for this die. Arc tan will default to the previous arc choice whether it be C.W. or C.C.W.

Select **1> TAPER**

Select [Norm] (for norm), lower right

Type (-1) for TAPER ANGLE. It must be negative if we want to cut a die as pictured earlier.

Press [ENTER RETURN]

Select **2> COMP**

Select [Right] from lower right on screen (must be the same as your choice in cycle data)

Type .0078 when the question COMP VALUE appears at lower right.

Press [ENTER RETURN]

Select ☒, intersection icon at lower left, if not lighted.

Select zoom if you want to enlarge a section of your geometry. After selecting zoom, put your cursor slightly outside of an outer corner of the area you want enlarged. To recall your original size, select RECL in the concurrent commands area. Hold mouse button in and move cursor until the area is bracketed. Release button on mouse.

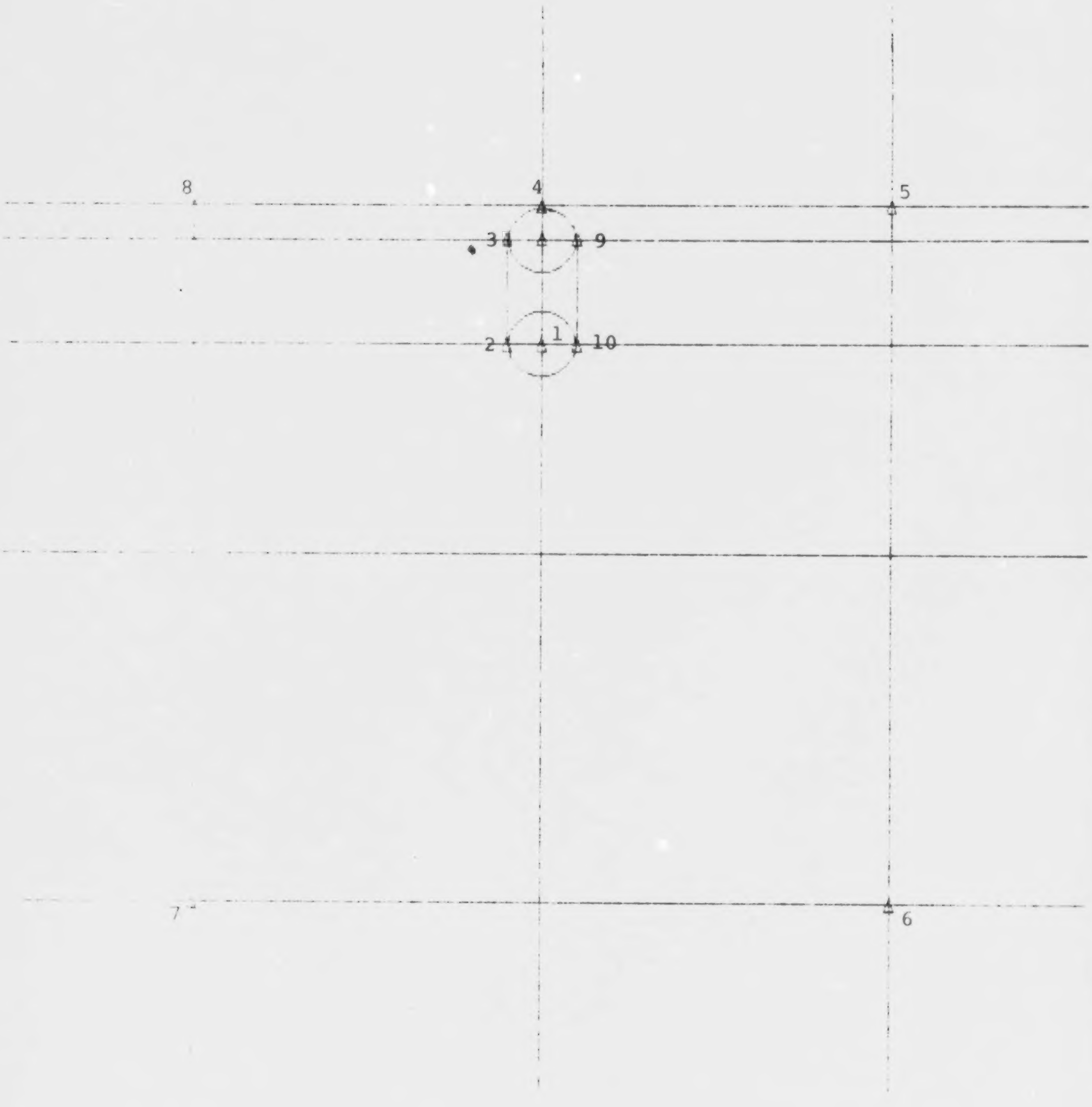
Select **5> CREAT PATH**

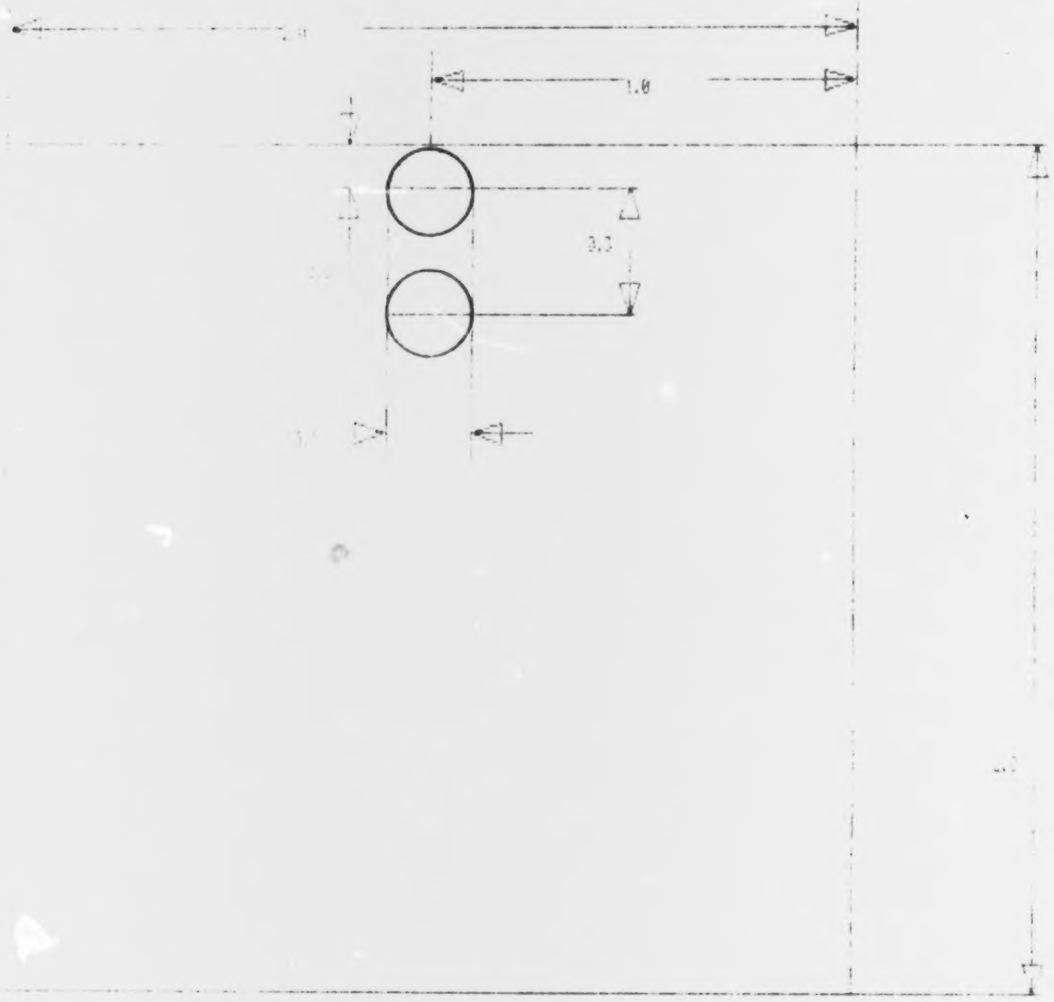
Select **1> DEFINE**

Select **2> LINEAR**

Select [Δ X] (INTERSECTION POINT ICON)

Select the points as shown on the example. Start at 1 and go 2 and 3. At 3, select **3> ARC CW**. Select point 4, point 5, point 6, point 7, point 8, point 4, point 9. Select **2> LINEAR**. Select point 10, point 1.




1.0

EDM WIRE PATH

Select **7> VERIFY**

Select **2> VERIFY CHK**

Your path appears in yellow. We have now created a program which will cut taper. We must now cancel the taper on our wire so that we can cut the straight land on our die.

Select **5> CREATE PATH**

Select **1> DEFINE**

Select **2> LINEAR**

Select **1> TAPER**

Select Off, at lower right

Select **2> COMP**

COMP STATUS appears at lower right

Select Right

COMP VALUE appears at lower right

Type .0056 (because this is a finish cut and our .010 wire will overburn by .0006)

Press ENTER RETURN

Select **1> SEG I.D.**, from second level menu

SEGMENT ID appears at lower left

Type 2-land. This is your new segment identification.

Press ENTER RETURN

If you only want the tool path to show:

Select "Eras"
Select "Evry"
From Concurrent Commands.

Select 1> **CONTOURING**

Skip cycle data because it is in from first seg.

Select 5> **CREATE PATH**

Select 3> **COPY**

SEGMENT ID appears in the prompts and messages area.

Type desired segment to be copied (1) (usually the first segment is taper and we will now copy it for a straight die wall).

Press ENTER RETURN

Path copied appears at lower left

Select 7> **VERIFY**

Select 3> **MOTION RECORD**

Select 4> **GLOBAL CHANGE**

Select 1> **TAPER**

Select Off

Select 2> **COMP**

Select Right

Comp value of .0078 appears at lower right

Type .0056

Press ENTER RETURN

To Save All Your Work

Select **4> DISK** in sipp

Type the directory (DIR) you want to save your info on, either:

A:\ or B:\

But use the A:\ or B:\ depending on which disc size you have.

Select part name. Use up to six numbers or letters.

Press ENTER RETURN

Select **4> SAVE**

Select **1> PART PROGRAM**

Select **2> GEOMETRY**

Select **5> QUIT**

Select **2> EXIT SIPP**

Confirm appears at lower left

Select Y for yes

To Post for the JAPAX

(JPXTIA or Mitsubishi MTZTIA Wire EDM)

For Downloading To The:

A. Machine
B. Printing of Program
C. Printing of TXT or text

Select **2> POST**

Change your **1> DIR** from A:\ to C:\EZ-CAM

ENTER NAME appears at lower left

Type **C:\EZ-CAM**

Press ENTER RETURN

Select **3> CNC NAME**

Type JPXTIA (for the JAPAX Wire EDM) or type MTZTIA (for the Mitsubishi EDM)

Press ENTER RETURN

DO YOU WANT TO LOAD JPXTIA? appears at lower left, or
DO YOU WANT TO LOAD MTZTIA? appears at lower left

Type Y

CNC INFO LOADED appears at lower left

Select **1> DIR**

Type A:\ or B:\ depending on which drive your disk is in.

Press ENTER RETURN

Select **4> PART NAME** (must be the same as the name used when you saved your work).

ENTER NAME appears at lower left

Type square

Select **5> OUTPUT NAME** (same as above)

Type square

Press ENTER RETURN

Select **6> NC OPTIONS**

- 1> Start Block = 1
- 2> Block Increm = 1
- 3> Insert Mode = Off
- 4> Screen List = On
- 5> Printer List = On

Select **7> SAVE OPTIONS**

OPTIONS SAVED appears at lower left

If you want a print, set switch box and turn printer on

Select off at **5> PRINTER LIST** above (If you don't want a print)

Select **8> RUN**

ARE YOU SURE? appears at lower left

Select Y for Yes

To Down Load To The Wire EDM

Select proper switch box position

Select **9> QUIT**

Do you want to exit post?

Type **Y** for yes

Select **5> UTILITIES**

Select **2> CNC COMMUNICATION**

Select **1> EZ-COM**

Select **2> FILES** from top of screen

Select **4> OUTPUT FILES**

Select **1> FILE NAME**

Type file name (6 letters or numbers) and .txt (Do not use spaces)

Press ENTER RETURN

Note: The following procedure is for the JAPAX Wire EDM.

Go to machine, select 19 store, D 9999 store, 11 store.

At computer, send file from A-drive by:

Select **2> SEND FILE**

Go to machine and select 1 store. Screen at machine should read "end iso" at bottom left. If it doesn't read "end iso," then select 19 store, D 9999 store, 11 store. Then re-send file.

For Re-try Only

Now go to machine

Select 1 store

Wait for end iso to appear on machine screen. Then program is at machine.

When "end iso" shows on the machine screen, you may enter optional stop, wire comp and taper.

The three procedures are listed below:

To Activate Optional Stop: (JAPAX)

Select 7 store
Block skip comes up with (1/0) 1=yes and 0=no
Select 0 and store
Error check appears
Select 0 and store
Optional stop appears
Select 1 and store (optional stop is activated at the machine)
Prior to this when drawing the path at the computer, pick optional stop by selecting "suffix." "Enter string" appears at lower left. For optional stop, type "M01". The "M" must be a capital.

To Activate Wire Comp: (JAPAX)

Select "9:D set"

Select STO -RE

Type at machine ".0078 D01"

Select STO -RE (This will put .0078 at the D01 location)

Type .0056 D02

Select STO -RE

Select / STO -RE This puts us back to menu screen.

To Activate Taper Angle: (JAPAX)

Select 10 STO -RE

Taper angle screen shows

Type "-.01746 A01" (This equals one degree). Make sure you use a negative.

Select STO -RE

Select / STO -RE This gets us back to the main menu.

Try dry run by doing the following: (JAPAX)

19 store
8 store
0 store
0 store

Screen should read "NC OK"

Opt. stop = 1, zero, X & Y by pressing both X CLR and Y CLR

Taper should not show on screen at the "U" and "V" symbols. (Do not shut system down if taper shows) (Do not just clear; take out manually with E TABL.

Press DRY RUN

To Get Geometry From Disk To Screen

Select **1> SIPP** from main menu

Select **4> DISK**

We should be in the directory that we saved the program in (usually A: drive).

Select **3> PART NAME**

Type part name (square)

Press ENTER RETURN

Select **5> LOAD**

Select **2> GEOMETRY**

GEOMETRY LOADED appears at lower left

Select Geom from the concurrent commands.

To Print From Screen

Press shift and 8 (two keys at same time)

DO YOU WANT THE PRINTER TO BE SET FOR A GRAPH DUMP?

Type Y for yes

PRINTER IS SET FOR GRAPH DUMP appears at lower left

Check that printer is on

Check switch box. This must be switched to the proper switching line.

Select Eras from concurrent commands

Select Geom from concurrent commands

Press shift and 8 again

CONFIRM REQUEST FOR PRINT... appears at lower left

Type Y for yes

OR

To Print While In SIPP With Geometry Showing on Monitor

Type "shift" and "8" together

Select erase

Select what you want printed from the concurrent commands (left side of screen)

1. geometry
2. path
3. grid
4. info (your seg)
5. evry

Type "shift" and "8"

At bottom of screen it says "Do you want print?"

Answer yes by selecting enter

To View A Part Path From A Disk

Select disk from sipp menu

Select part name

Type part name and press enter

Select load

Select part program

Select every, bottom left, for all paths

Printer

Objective: To load paper and operate the printer from the computer.

Procedure and Information:

1. Lift the large plastic cover on the printer. Raise the wire paper guard and roller.
2. Lift both black cog wheel clips.
3. Pull the ruler (perper pusher 8" long) which is in front of the cog wheels towards you.
4. Insert the paper over the roller which is on the wire paper guard and under the wire guard.
5. Push the paper into the opening behind the wire guard and when it comes up, align the holes in the paper with the cogs. Only pull the paper out far enough to align the paper serrations with the bottom edge of the little black "cog locks." You can also use the black hand wheel at the right side of the printer. See sketch below:
6. Push cog locks, wire paper guard ruler and plastic cover back into position.
7. At the right side of the printer, you should turn the printer to "on."
8. Three lights must be on for the printer to work.

9. If the "on line" light is on, press it and it will go out. This will now enable you to use either the "FF" or "LF" button. The "FF" button will advance the paper one full sheet. The "LF" button will advance the paper approximately one line.
10. To start the printer, hit letter "O" and you will be asked to confirm with a hit on the keyboard "Y" for yes, or on the screen with a click on the mouse and cursor above the yes/no line, for a yes. See below.

11. Printing will then start immediately. When the print is finished, note that the window size and the part size relate to each other.
    EXAMPLE: If you draw a 3" window (Window equals the maximum part size that will fit on your print) and a 2.9 square part will practically fill the window and also the print you made. Your maximum window size is 11" square.
12. If your printed circles come out as ellipses, re-run the printer.
13. Printer check: With all equipment on, turn printer off. Two buttons, on-line and "LF" must then be held donw. Turn on printer. A total check of numbers, letters, and tape will take place. Turn off when you're satisfied or the printer will keep running.

Notes:

PRINCIPLES OF WIRE-CUT ELECTRICAL DISCHARGE MACHINING (EDM)

Introduction

EDM machining is a thermal process. The material is removed by heating the workpiece to a temperature that the material is vaporized. There is no contact between the wire electrode and the workpiece when machining is taking place. If contact is made, burning will immediately stop. By increasing or decreasing the amount of spark energy applied to the workpiece determines how fast the removal rate of material will be. Increasing or decreasing the amount of spark energy will also affect how coarse the surface finish of the wire-cut part will be. Because of the high temperatures, the wire and chips must be cooled. The dielectric fluid is used for this. It forms a barrier between the wire electrode and the workpiece. Without this fluid the wire would burn up immediately because of the high electrical current that is being produced.

Objectives

Upon successful completion of this lesson, the trainee will acquire the knowledge of:

1. EDM motor drives.
2. Spark on and off time and surface finish.
3. Spark overcut.
4. Importance of dielectric fluid and flushing.
5. Dielectric cooling.

PRINCIPLES OF WIRE-CUT ELECTRICAL DISCHARGE MACHINING (EDM)

Wire-cut EDM is a process for machining electrically conductive materials by sparks in the presence of a dielectric using a traveling wire as the cutting tool. Wire-cut EDM has been described as an electronic band saw. This description is quite good since the shape machined is basically two dimensional and is always machined completely through the workpiece.

Basic components of Wire-Cut EDM machine are shown in Figure 1 and consist of:

A. EDM Power Supply which controls spark energy in the form ON time, OFF time, peak emperes and machining voltage.

B. Electrode wire system which controls the wire traverse rate and the tension on the wire.

C. Dielectric unit which provides the fluid necessary to control the sparking conditions, provide cooling for the workpiece and the electrode wire and remove the EDM chips from the machining area.

D. CNC unit for controlling the shape to be machined.

E. Machine structure which supports the X-Y positioning system.

Position System

Wire-Cut EDM requires the movement of the workpiece on the electrode in the X and Y axes. When cutting a perpendicular face moves and the electrode wire remains stationary. In some instances the workpiece may travel in the Y-direction and the electrode wire will travel in the X-direction. It is even possible that the electrode would travel in both the X and Y directions with the part being stationary. It makes no difference how the X and Y movements are made so long as there is relative movement between the electrode and the workpiece.

Precision of movement is of prime importance to the X-Y positioning system. Antifriction table ways for X and Y travel assure that the system will respond to the drive motor movement in minute increments.

DRIVE MOTORS

Drive motors must be coupled to the lead screws so that there is no backlash in the system and finally the drive motor must be capable of responding to very small positioning commands. Normal input command to a drive motor may be as small as .00004" (.001 mm). This type of control is necessary to keep the electrode wire in proper position for greatest sparking efficiency as well as to produce the precision in the workpiece shape. Pre-loaded ball bearing lead screws also assure that the drive motor movement is transmitted to the table slides with a minimum of friction.

Movement of the X-Y axes is under the command of the CNC control. The two axis contour is programmed into the CNC control unit.

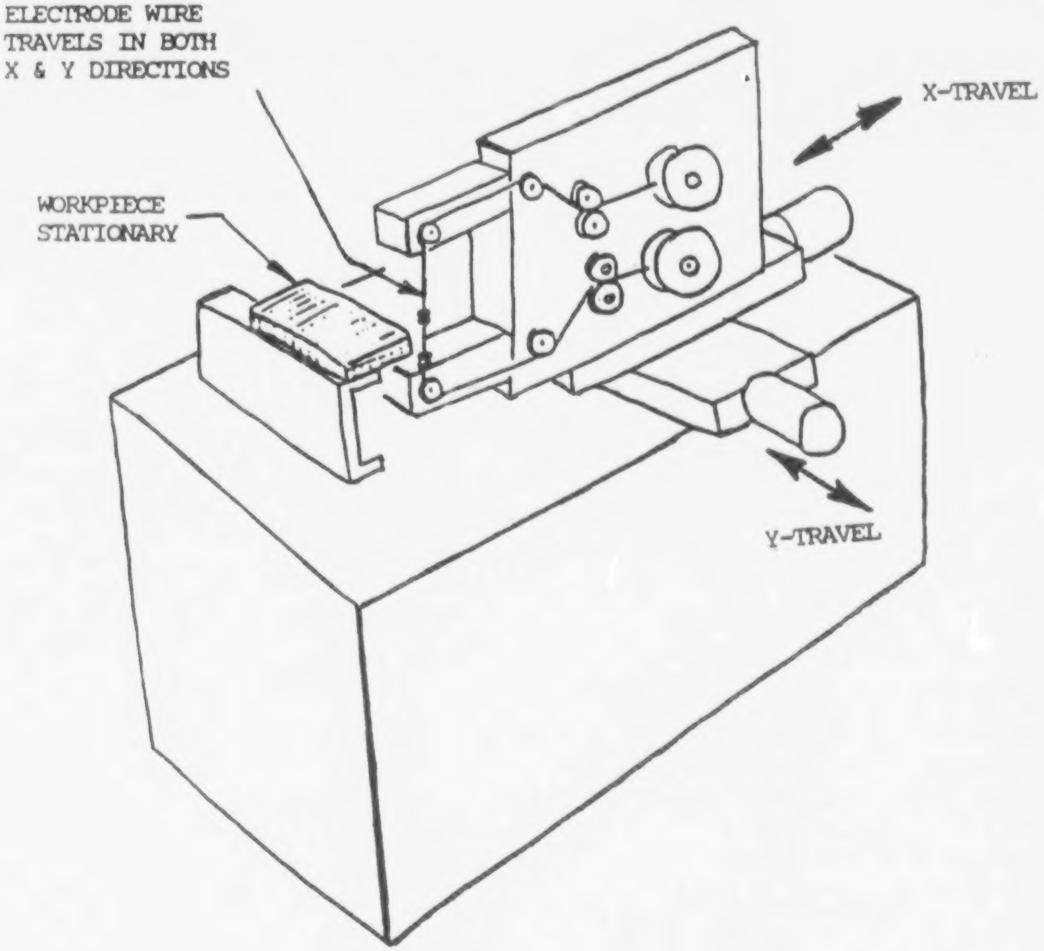
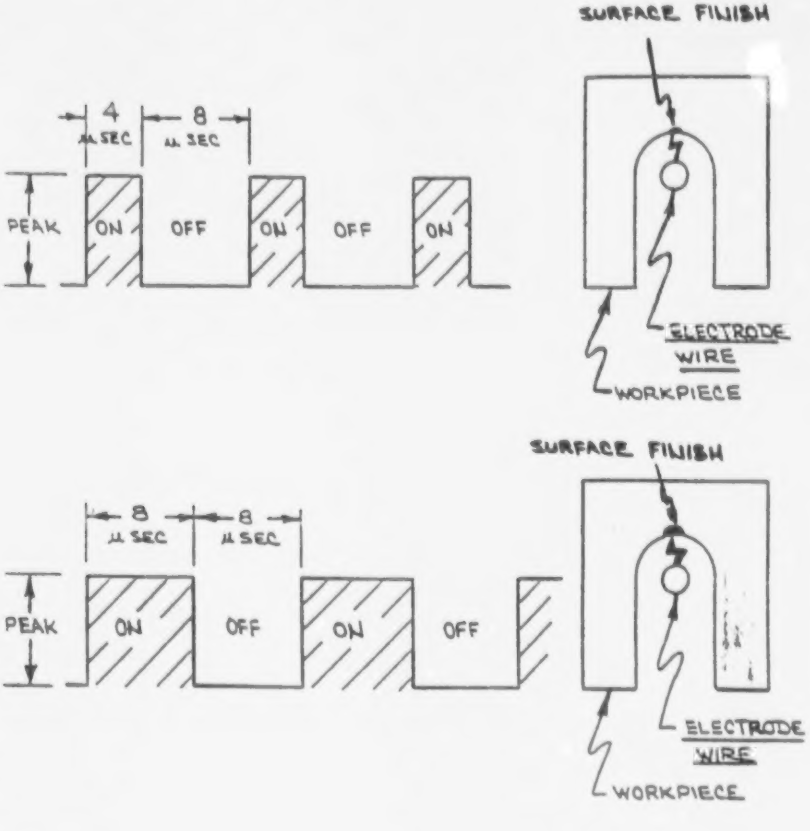


FIG. 1. WIRE-CUT EDM MACHINE WITH ELECTRODE WIRE TRAVEL X & Y DIRECTIONS & WORKPIECE STATIONARY

ON & OFF TIME

ON time is one of the controlling factors in determining spark energy. For the consideration at this point all other factors will be considered constant. Figure 2 illustrates the affect that ON time has on spark energy. The top example shown an ON time of 4 usec and an OFF time of 8 usec. Spark energy in this illustration is based on 4 usec. The lower example establishes a spark energy of 8 usec. The lower example then has twice the spark energy of the upper example. More spark energy produces a higher energy spark which removes more material. It should be noted that higher spark energy also produces a coarser surface finish.


SURFACE FINISH
4 μ SEC
8 μ SEC
PEAK
ON
OFF
ON
OFF
ON
ELECTRODE WIRE
WORKPIECE
SURFACE FINISH
8 μ SEC
8 μ SEC
PEAK
ON
OFF
ON
OFF
ELECTRODE WIRE
WORKPIECE

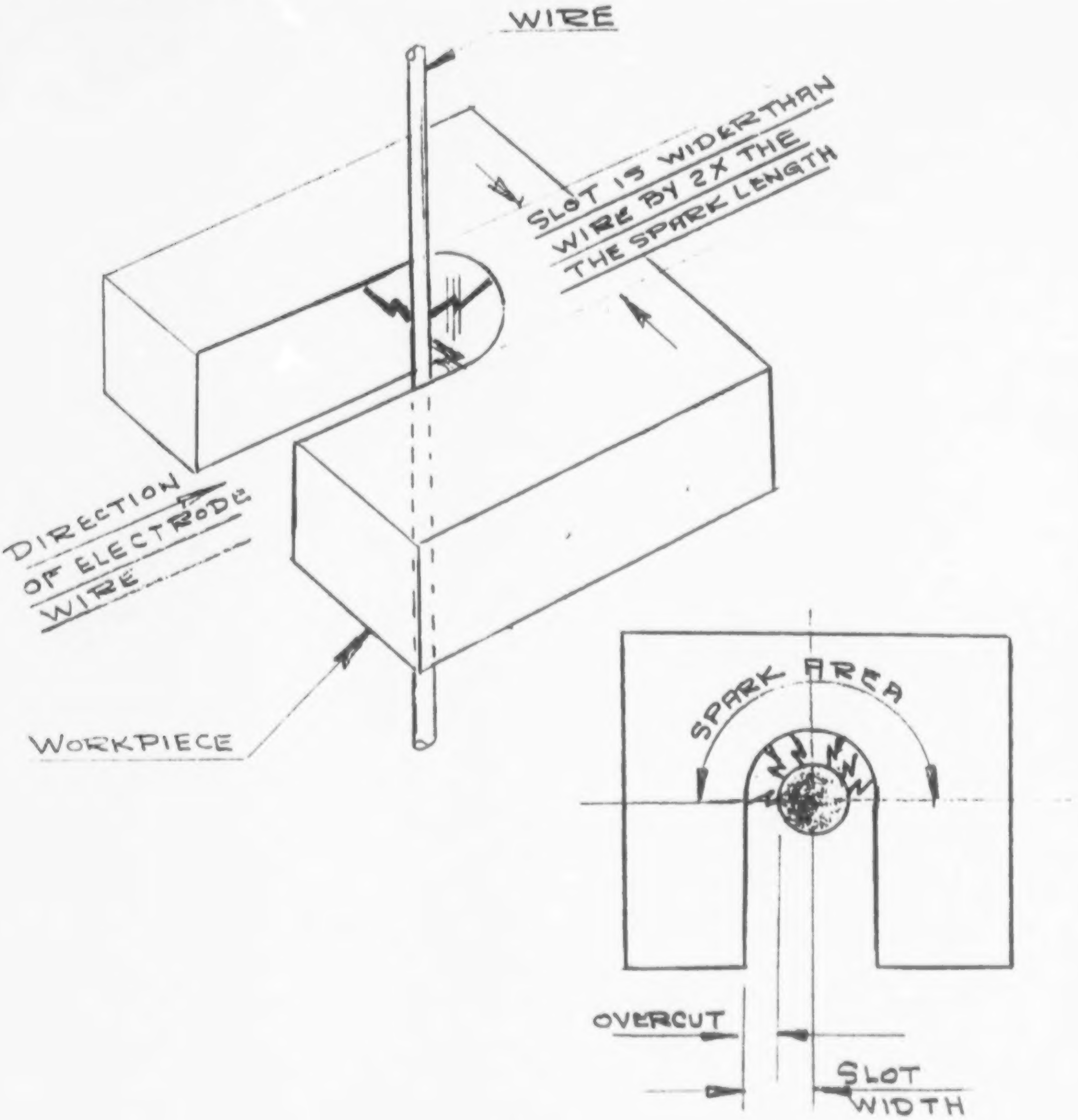
INCREASE ON-TIME = INCREASE IN SPARK ENERGY
(PEAK VALUE MAINTAINED AT SAME VALUE)

FIG. 2. ON-TIME DETERMINES SPARK ENERGY

OVERCUT (SPARK LENGTH)

Wirecut EDM is the same as other machining processes. The opening machined is larger than the cutting tool. In other words, the slot machined by the wire is larger than the wire diameter. The reason for this is that there must be space for the spark between the elcetrode wire and the workpiece material (Figure 3). If the wire contacts the workpiece, a short will occur and burning will stop.

Since overcut is based on spark length, it can be established that the kerf width will be:


WIRE
SLOT IS WIDER THAN WIRE BY 2X THE SPARK LENGTH
DIRECTION OF ELECTRODE WIRE
WORKPIECE
SPARK AREA
OVERCUT
SLOT WIDTH

METAL REMOVAL

The rate at which metal is removed by Wire-Cut EDM is dependent on two (2) things:

A. The closeness of one spark to the next spark.

B. The energy in each of the sparks.

Energy in the spark has been shown to increase as the ON time of the spark increases. As spark energy increases, metal removal rate increases (Figure 4). The upper illustration shows a spark energy based on a 4 usec ON time. The lower illustration has a spark ON time of 8 usec. In both illustrations the OFF time is 8 usec. Doubling the ON time (i.e. from 4 usec to 8 usec) also doubles the spark energy. Doubling the spark energy doubles the volume of workpiece material removed per spark. A basic rule can then be established:

INCREASED SPARK ENERGY INCREASES METAL REMOVAL

There is one other factor that must be considered at this time. Notice that the 4 usec spark energy produces a smaller crater than the 8 usec. spark. Since the higher energy spark increases the metal removal, it also results in a coarser surface finish. From this, the basic rule for spark energy and metal removal can be modified to:

INCREASING SPARK ENERGY

- INCREASES METAL REMOVAL
- PRODUCES A COARSER SURFACE FINISH

It is possible to increase metal removal when using Wire-Cut EDM without changing surface finish. This is accomplished by establishing the ON time for an acceptable surface finish. The OFF time is then reduced to increase the number of sparks per second (Figure 5). Each spark has the same spark energy so the same volume of material is removed per spark and the surface finish remains the same. Decreasing the OFF time allows the sparks to happen more often so metal removal rate is increased.

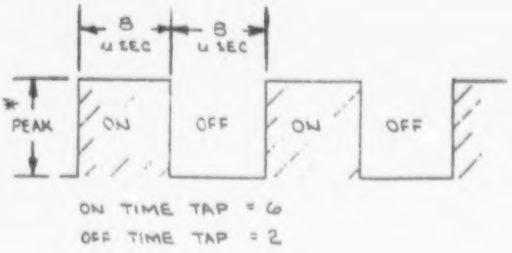
It is possible now to state another rule with regard to Wire-Cut EDM:

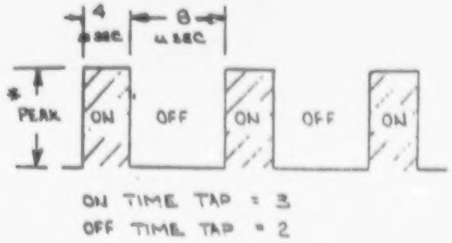
MAINTAINING SPARK ENERGY WHILE DECREASING OFF TIME

- INCREASES METAL REMOVAL RATE
- DOES NOT CHANGE SURFACE FINISH

In actual operation of the Wire-Cut EDM machine decreasing OFF time while maintaining the spark energy does have limitations. It is possible to decrease the OFF time to the point that excess heating of the electrode wire would take place and wire breakage would result.

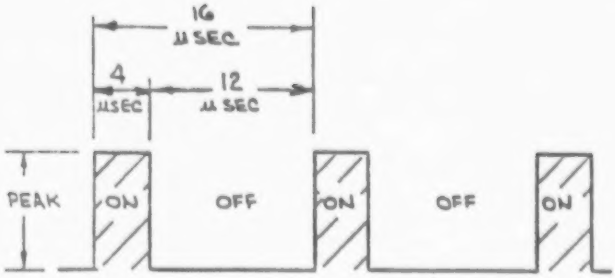
On-Time Affect On Surface Finish

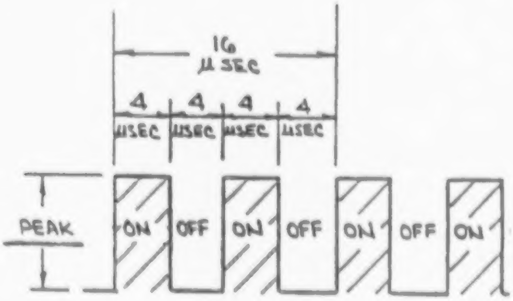

8 µSEC
8 µSEC
*
PEAK
ON
OFF
ON
OFF
ON TIME TAP = 6
OFF TIME TAP = 2


4 µSEC
8 µSEC
*
PEAK
ON
OFF
ON
OFF
ON
ON TIME TAP = 3
OFF TIME TAP = 2

Double "ON TIME" = DOUBLE REMOVAL.PER SPARK
= COARSER SURFACE FINISH

Off-Time Decrease & Metal Removal Rate


16 µSEC
4 µSEC
12 µSEC
PEAK
ON
OFF
ON
OFF
ON

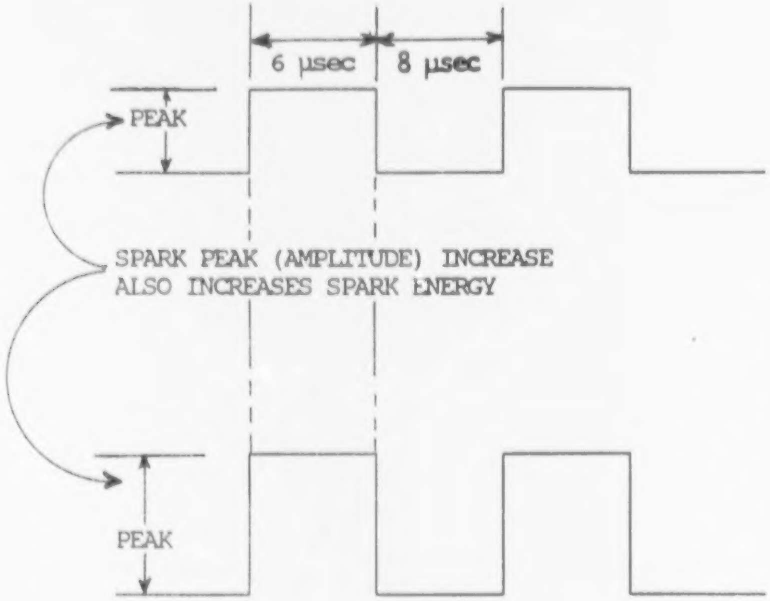

16 µSEC
4 µSEC
4 µSEC
4 µSEC
4 µSEC
PEAK
ON
OFF
ON
OFF
ON
OFF
ON

KEEPING SPARK ENERGY THE SAME WHILE
DECREASEING SPARK OFF-TIME
- increases number of sparks per second
- increases metal removal rate
- keeps surface finish the same

(Peak Current)

With the exception of the PEAK control, all other settings will be considered constant. PEAK describes the height of the square wave pulse. To this point, PEAK has been considered constant in the examples shown. In reality, PEAK has been considered constant in the examples show. In reality, PEAK increases spark energy as the amplitude (height) of the square wave is increased.

Figure 6 shows the way in which PEAK increases spark energy. Both illustrations have the same ON and OFF time. The data in the chart shows that PEAK (amperes) increase as the control is set at a higher number. Since ON time and OFF time are not changed in the illustration, it can be seen that the PEAK control changes the amplitude (PEAK) of the spark pulse. A higher or lower spark PEAK brings about a corresponding increase or decrease in SPARK ENERGY.



SAME ON TIME
SAME OFF TIME
INCREASE PEAK } INCREASE SPARK ENERGY

SPARK ENERGY INCREASE WITH PULSE PEAK CONTROL

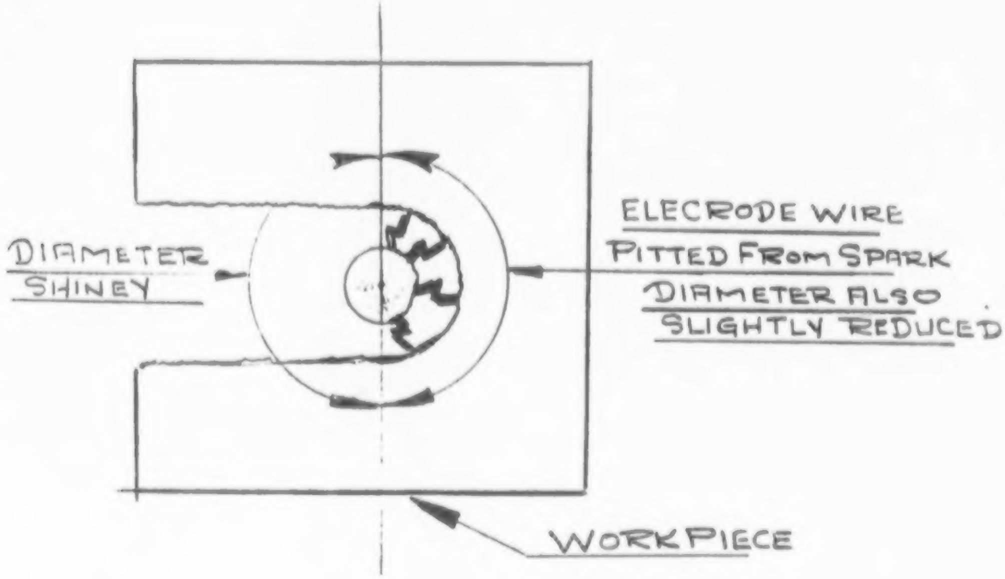
Electrode Wire

The cutting tool for Wire-Cut EDM is the electrode wire. This wire carries the electrical energy in the form of a spark to machine the workpiece. Since the spark does the actual machining without having the wire touch the workpiece, a small diameter brass wire can be used to machine hardened steel or carbide.

Many different materials are used for electrode wire. Some common materials are copper, brass, molybdenum (moly) and tungsten. Brass is probably the most used. Moly and tungsten are used mostly where a small radius is required on an inside corner. These materials have more strength in tension than copper or brass.

Electrode wire is used in a diameter range of from .002" to .016". Of this range of sizes, probably .008" and .010" diameters are most used.

Sparks erode both the electrode wire and the workpiece. As the wire passes through the sparking area, sparking energy is tansferred from the wire to the workpiece. As the spark takes place, it heats a portion of the workpiece surface and material is removed. At the same time, the spark heats the surface of the electrode wire and material is removed from the wire. By comparison, a much smaller amount of material is removed from the wire than the work surface. The electrode wire then takes on a different appearance (Figure 7) as it moves through the work area. The erosion on the wire weakens it to the point where it is not usable as an elctrode wire. For this reason, electrode wire is used once and discarded.

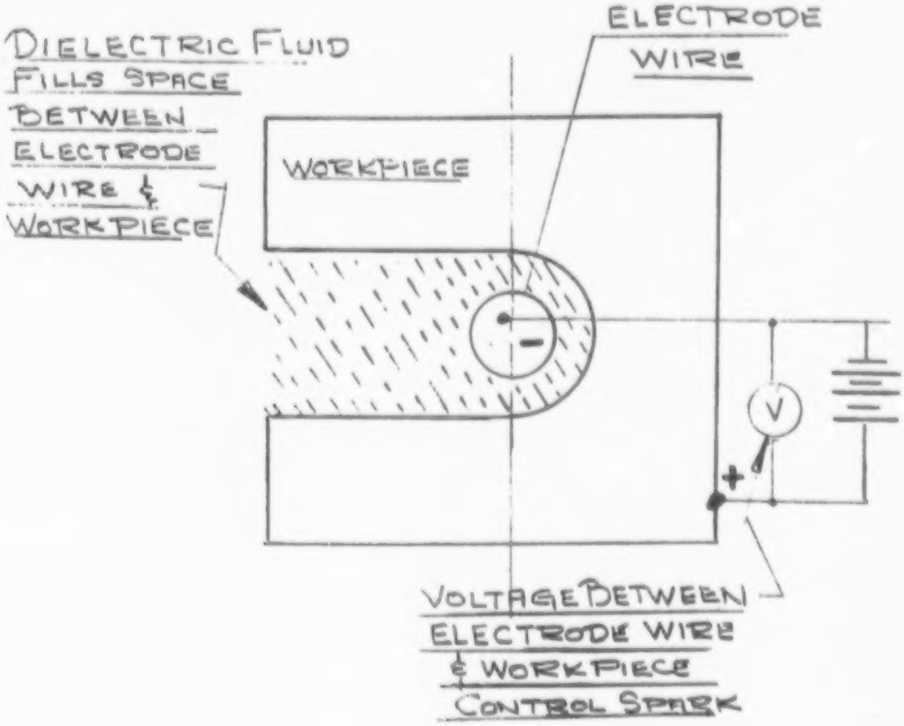

DIAMETER SHINEY
ELECRODE WIRE PITTED FROM SPARK DIAMETER ALSO SLIGHTLY REDUCED
WORKPIECE

Dielectric

The dielectric fluid used in Wire-Cut machining operations is normally deionized water. This fluid performs three (3) functions. They are:

1. The sparking area is surrounded by a material having known dielectric characteristics.
2. The fluid cools the electrode wire and the workpiece.
3. The fluid transports the machined particles away from the sparking area.

Dielectric is an electric term which denotes a non-conductor of electricity. De-ionized water is a non-conductor of electricity until a voltage is applied between the electrode wire and the workpiece which is high enough to cause the water to break down (Figure 8). At that point (called ionization point), the water becomes a conductor of electricity. When the voltage is removed, the flow of electric current ceases and the water returns to its normal condition as a dielectric. This process is repeated for each spark at the rate of many thousands of times per second.


DIELECTRIC FLUID FILLS SPACE BETWEEN ELECTRODE WIRE & WORKPIECE
ELECTRODE WIRE
WORKPIECE
−
+
V
VOLTAGE BETWEEN ELECTRODE WIRE & WORKPIECE CONTROL SPARK

FLUSHING

Since the dielectric material is so important in the sparking cycle, it is also very important that it be very closely controlled during the wire-cut EDM machining cycle. Surrounding the EDM machining area with the fluid is normally accomplished by flowing the water under pressure at the point where the wire enters the cut and also where the wire exits (Figure 9). It is most important that the water completely surround the sparking area so that a known dielectric condition exists.

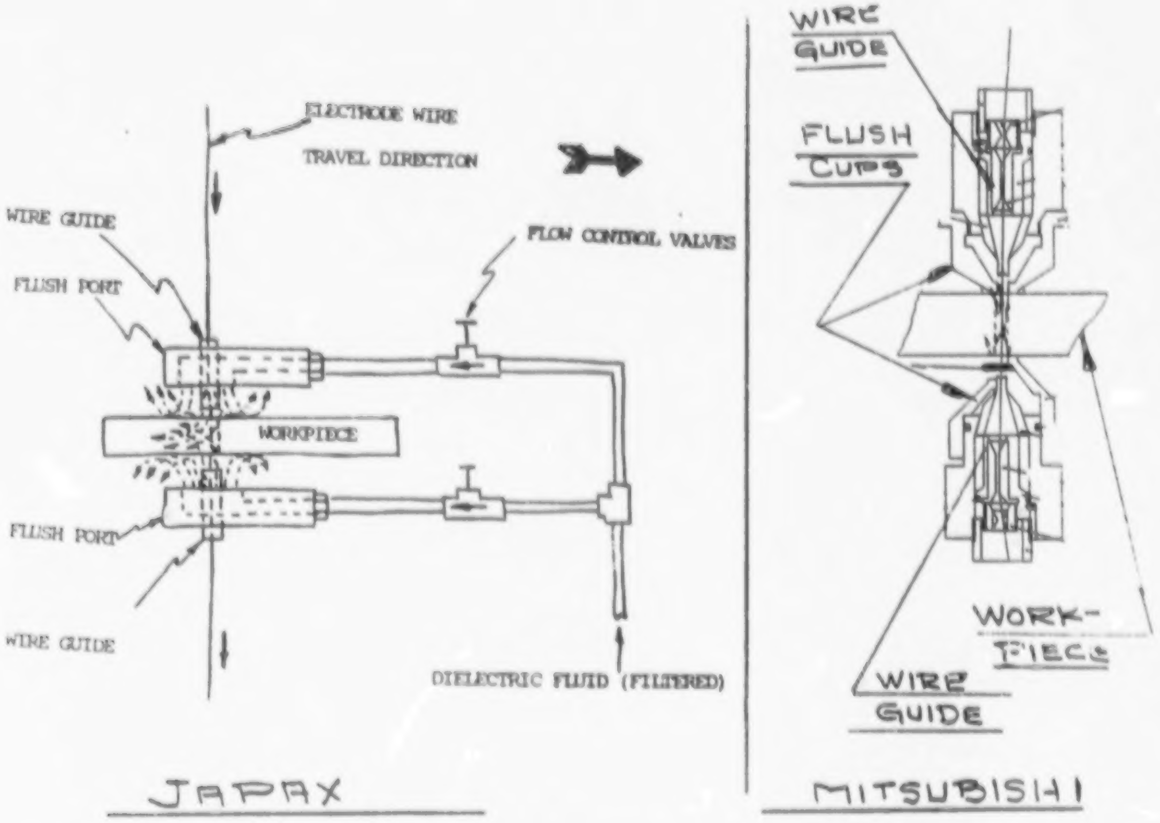

ELECTRODE WIRE
TRAVEL DIRECTION
WIRE GUIDE
FLUSH PORT
FLOW CONTROL VALVES
WORKPIECE
FLUSH PORT
WIRE GUIDE
DIELECTRIC FLUID (FILTERED)
JAPAX
WIRE GUIDE
FLUSH CUPS
WORK-PIECE
WIRE GUIDE
MITSUBISHI

FIG. 9. SYSTEM FOR SURROUNDING WIRE WITH DIELECTRIC

THERMAL PROCESS

Electrical Discharge Machining is a thermal process. This means that material removal is accomplished by heating the workpiece to the point that the material is vaporized (Figure 10). Heating however, is limited to a very small area of the workpiece surface. Because the energy per spark is very small, the heat of the vaporized material can be removed quickly by the dielectric fluid. When proper fluid flow is used, the workpiece and electrode wire should never feel warmer than the temperature of the dielectric fluid being used.

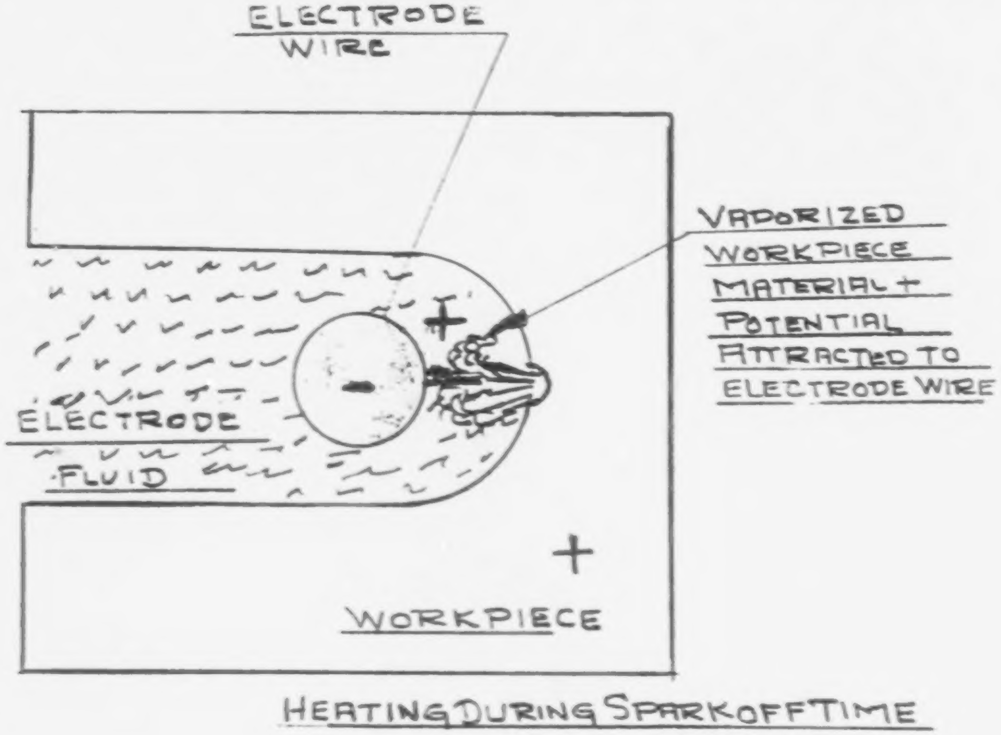

ELECTRODE WIRE
VAPORIZED WORKPIECE MATERIAL + POTENTIAL ATTRACTED TO ELECTRODE WIRE
+
-
ELECTRODE FLUID
+
WORKPIECE
HEATING DURING SPARK OFF TIME

FIG. 10. SPARK ENERGY HEATS & VAPORIZES WORKPIECE MATERIAL

Dielectric Cooling

Cooling of the vaporized material causes the vapor to re-solidify (Figure 11). The vapor then becomes a solid and takes the shape of a very small sphere. The sphere is very small. For most machining, the diameter of the sphere would be less than .0005" (.012 mm). The sphere is actually the EDM "chip".

EDM chips are produced at rates of many thousands per second. As with any machining process, the chips must be removed or inefficient machine operation will result. Chip removal for Wire-Cut EDM is accomplished by causing the dielectric fluid to move through the sparking area (Figure 11). The movement of the fluid transports the chips away from the surface being machined and assures that uncontaminated fluid is always present in the sparking area.

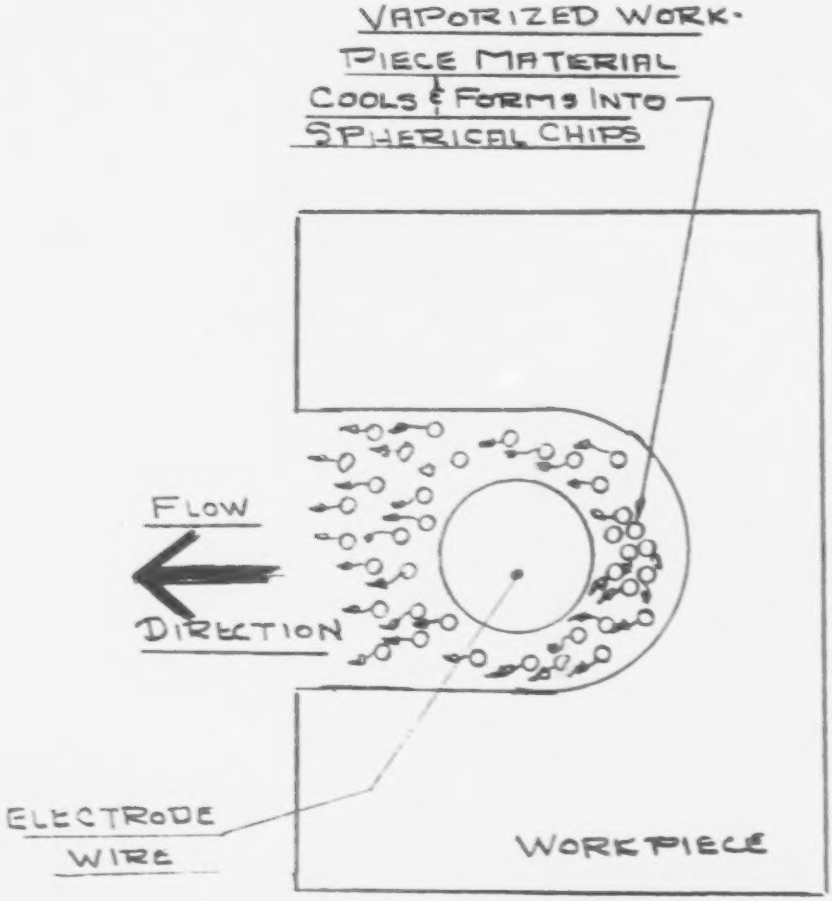

VAPORIZED WORK-PIECE MATERIAL COOLS & FORMS INTO SPHERICAL CHIPS
FLOW
DIRECTION
ELECTRODE WIRE
WORKPIECE

FIGURE 11
VAPORIZIED WORKPIECE
MATERIAL COOLED & FLUSHED
DIELECTRIC FLUID

SUMMARY
WIRE-CUT EDM PRINCIPLES

1. EDM is a thermal process. Material is removed by heat.

2. Both the electrode wire and workpiece must be materials that conduct an electric current.

3. Machining is accomplished by sparks.

4. EDM sparks contain energy.

5. Spark energy does the machining. There is no contact between the electrode wire and workpiece when machining is taking place.

6. Spark energy is determined by
   (a) SPARK ON TIME
   (b) SPARK PEAK

7. Spark energy determines
   (a) material removed per spark
   (b) surface finish

8. Increasing spark energy
   (a) increases material removed per spark
   (b) produces coarser surface finish

9. Decreasing spark energy
   (a) decreases material removed per spark
   (b) improves surface finish

10. Decreasing SPRAK OFF time
    (a) increases metal removal rate
    (b) does not affect surface finish

11. Increasing SPARK OFF time
    (a) decreases metal removal rate
    (b) does not affect sruface finish

12. Dielectric fluid is used to
    (a) form a dielectric barrier between the electrode wire and the workpiece
    (b) cool the chips
    (c) remove the chips from the work area

Notes:

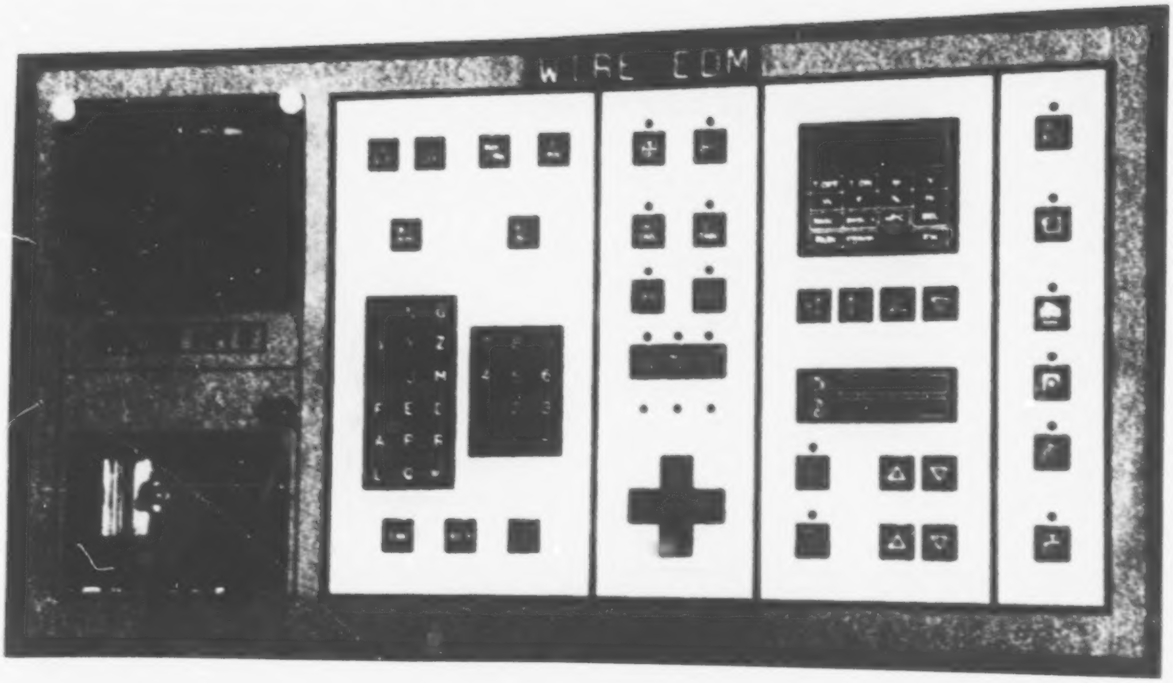
UNIT #14. KEY NAMES AND FUNCTIONS OF THE JAPEX WIRE EDM CONTROL

After completion of Unit #14 you will able to:

Identify and select the proper key functions to enter a manual program.

Identify and select the proper key functions to manually operate the Japex Wire EDM.

UNIT #14. KEY NAMES AND FUNCTIONS OF THE JAPEX WIRE EDM CONTROL



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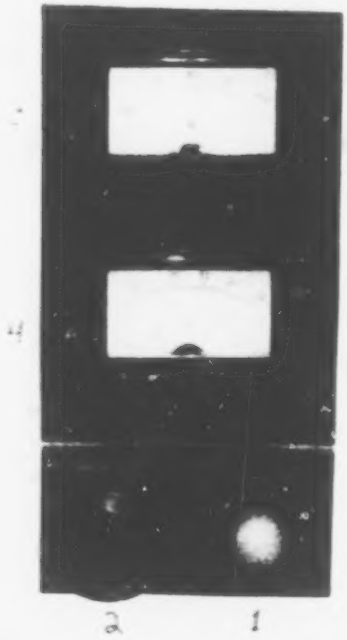
Power Supply Unit

1 Power on switch
Depress this switch and hold it in until it lights up the lamp and supplies electrical power to the machine tool and other equipment.

2 Power off switch
Depress this switch to turn all power off. Rotate clockwise to unlock the switch.

3 Machining voltmeter
Average machining voltage is indicated.

4 Machining ammeter
Average machining current is indicated.



Power Supply Unit Control Panel

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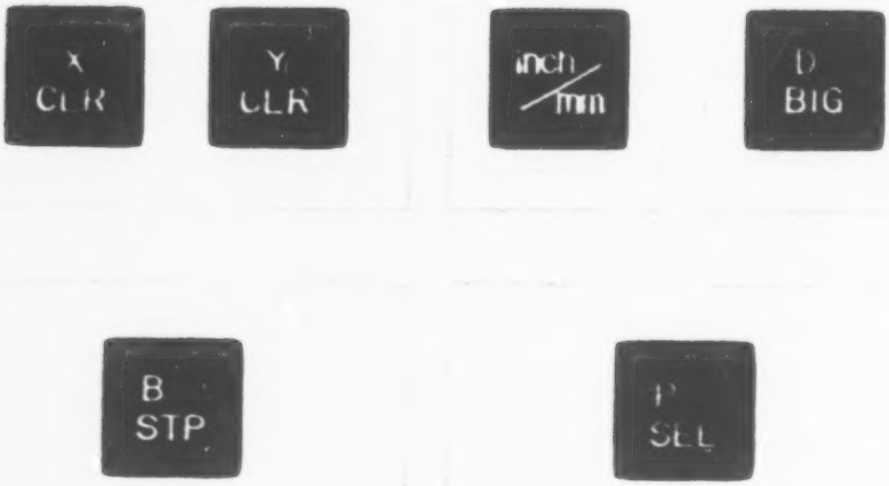
CRT Control Keys



1

Page Select Key
Each time this key is depressed, the status display and the select display (MAIN MENU) can be alternately viewed on the screen.

Status Display

```
N 0000   inch     X MIRR      0
X    00.00000     Y MIRR      0
Y    00.00000     X/Y CHG.    0
U    00.00000     M.LOCK      0
V    00.00000     OPT.STOP    0
S    00.00000
                  B.LASH X           0
                  B.LASH Y           0
                  E.C U        0.70409
                  E.C V        0.70740
```

The present XY, UV positions and various operational settings are indicated in the status display.

Select Display
commonly called the MAIN MENU

```
 1 : MEMORY CALL      2 : E.C. SET
 3 : BACK LASH        4 : E.C. ORG
 5 : X/Y MIRR.        6 : M.LOCK
 7 : B.SKIP(0) E.CHK(0) 0.STOP
 8 : NC SET           9 : D SET
11 : TAPE READ       10 : A SET
13 : DATA EDIT       12 : M SET
15 : P.D AUTO (0)    14 : P SET
19 : NC RESET        18 : NC D.RUN
   = _
```

Input procedure for data and settings are indicated in the select display mode.

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2

X-Axis Clear Key
When in M Table the present X-axis position display is cleared. When in E Table (EDGE-CUT) the present U-axis position display will be cleared.

3

Y-Axis Clear Key
When in M Table the present Y-axis position display is cleared. When in E Table (EDGE-CUT) the present V-axis position display will be cleared.

4

Inch/Metric Key
The present positions on the XYUV axes can be alternately displayed in inches or millimeters.

5

Page Magnification Key
In the status display mode, depressing this key will magnify the left half, or the present position data, of the display. Depressing the key once more will revert to the original status display.

6

Block Stop Key
Depressing key alternately energizes or deenergizes the block stop function. When block stop is energized, the letters "B.STOP" will appear on the CRT status display, and the program will stop after each programmed block.

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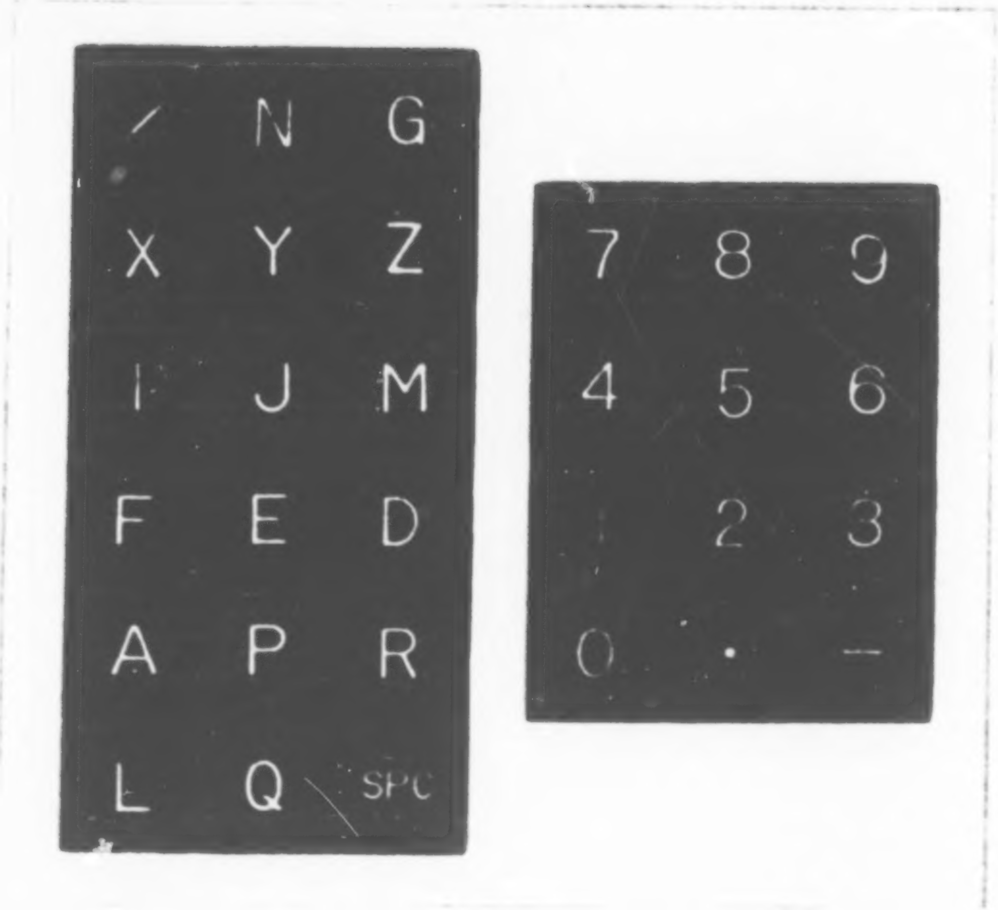
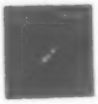
Address Keys



1 

Return Key
Return to main menu from
- 9 - Wire Compensation
- 10 - Edge Cut
- 12 - M-Set
- 13 - Data Edit

2

Block No. Key
Program line number followed by 4 digit block number since zero suppression is allowed, keying in N 1 = N0001.

3

Preparatory Function Key
Address key for instruction of preparatory function.

4

X Data Key
Address key for input of X-axis coordinate.

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5	Y	Y Data Key Address key for input of Y-axis coordinate.
6	Z	Z Data Key Not used.
7	I	I Data Key Address key for input of X-axis data of arc center. Use increment from the center to the starting point of the arc. In DATA EDIT instruction for insertion is given.
8	J	J Data Key Address key for input of Y-axis data of arc center. Use increment from the center to the start point of the arc.
9	M	Auxiliary Function Key Address key for instruction of auxiliary function.
10	F	Feed Rate Key Address key for specifying feed rate.
11	E	E Key Address key for instruction of EDGE-CUT data.
12	D	D Key Address key for input of wire compensation. D01 through D09 are used for storing wire compensation data. In DATa EDIT instruction for deletion is given.
13	A	Angle Key Address key for input of EDGE-CUT angle. A01 through A09 are used to store taper angles.
14	P	P Key Address key for the correction of program.
15	R	R Key Address key for input of arc radius, instead of using keys I and J. In DATA EDIT instruction for replacement is given.
16	L	L Key Not used.
17	Q	Q Key Address key for input of program copy (G27 end block number.

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18

Space Key
Key for input of space between words in programming. In DATA EDIT space between items being replaced.

19

Numeric Data Keys
Keys for input of data. This includes the decimal point and signs (+ and -).

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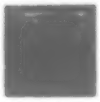
Editing Keys

1

Cancel Key
This key is used to correct keyed-in characters during program editing. However, it must be used prior to depressing (STORE). It will clear the last line in its entirety, thus, allowing the new data to be entered.

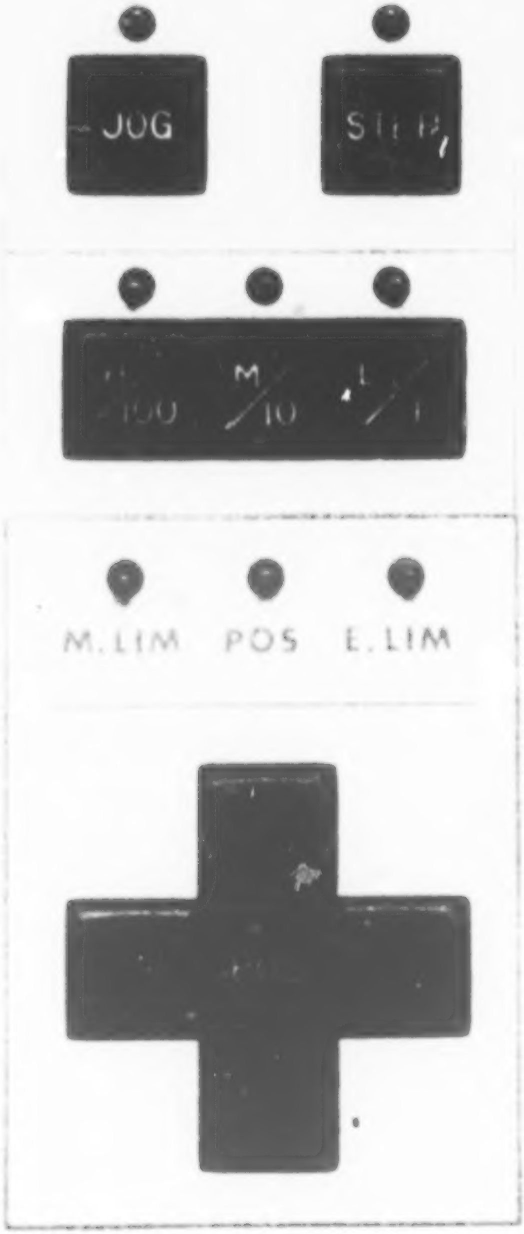
2

Back Key
This key is used for amending the previously entered data. Depressing this key will move the cursor and erase the last entry left each time it is depressed.

3 

Store Key
This key is used for the input of data into memory. Keyed-in data will not be stored in memory until this key is depressed.

Table Feed Keys


JOG
STEP
H/100
M/10
L/1
M.LIM
POS
E.LIM

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1 Table Feed Key

During manual operation, depressing any one of these keys will enable the main (M TABL) or EDGE-CUT (E TABL) to move in the axis direction indicated. For EDGE-CUT table, X and Y refer to U and V axes respectively.

2 Manual Positioning Key

Depressing this key lights up the lamp and permits manual positioning with the table feed keys. The buzzer sounds when the workpiece and wire are in contact.

NOTE: Make sure that:

1) Wire feed "ON"
2) Wire tension "ON"
3) Wire breakage detecting switch is properly set

3 Jog Feed Select Key

During manual operation, pressing this key lights up the lamp and enables table movement in whatever axis direction is depressed.

4 Step Feed Select Key

During manual operation, pressing this key lights up the lamp and enables table movement in 1 step. Press table feed keys in the direction needed. The step length can be set with the "table feed rate/step length selection" key.

5 Table Feed Rate/Step Length Selection Key

Pressing this key lights up the lamp and enable the setting of jog rate or the setting of step length as listed below.

Item	Selection Key	H/100	M/10	L/1
JOG (mm/min)	M.TABL E.TABL	600 60	180 30	60 15
STEP (um)	M.TABL E.TABL	100	10	1

6 Overtravel Lamp (M. LIM)

This lamp lights when the main table reaches the stroke end and actuates the limit switch.

7 Manual Positioning Lamp (POS)

Turning on the manual positioning key lights up the lamp.

8 EDGE-CUT Table Overtravel Lamp (E. LIM)

This lamp lights when the EDGE-CUT table reaches the stroke end and actuates the limit switch.

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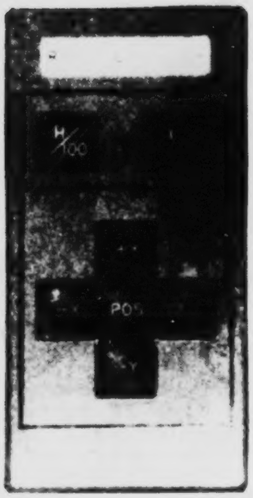
Remote Controller



1

Table Feed Rate/Step Length Selection Key

Pressing either of these keys enables the setting of jog rate for high and low speeds, or the setting of step length 100 um or 1 um when the corresponding key on the control panel is depressed.

2

Manual Positioning Key

Manual positioning can be made as by the corresponding "manual positioning key" on the control panel. (See #2 on Control Panel table).

3

Table Feed Key

Table feed in XY or UV axes can be made as by the corresponding "table feed key" on the control panel. (See #1 on Control Panel table).

4

Overtravel Lamp

When the main or EDGE-CUT table reaches the end of its stroke and actuates the limit switch, this lamp will light as the overtravel lamp on the control panel.

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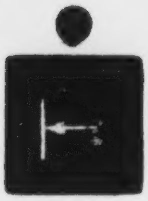
Set-up Keys



1

Automatic Hole Center Positioning Key
Pressing this key and any table feed key will activate the automatic hole center positioning to start in the direction pressed. A buzzer sounds on completion. Hole diameter should be less than 2 inches.

2

Automatic Edge Positioning Key
Pressing this key and a table feed key enables edge positioning to start in the direction of the pressed table feed key. A buzzer sounds on completion.

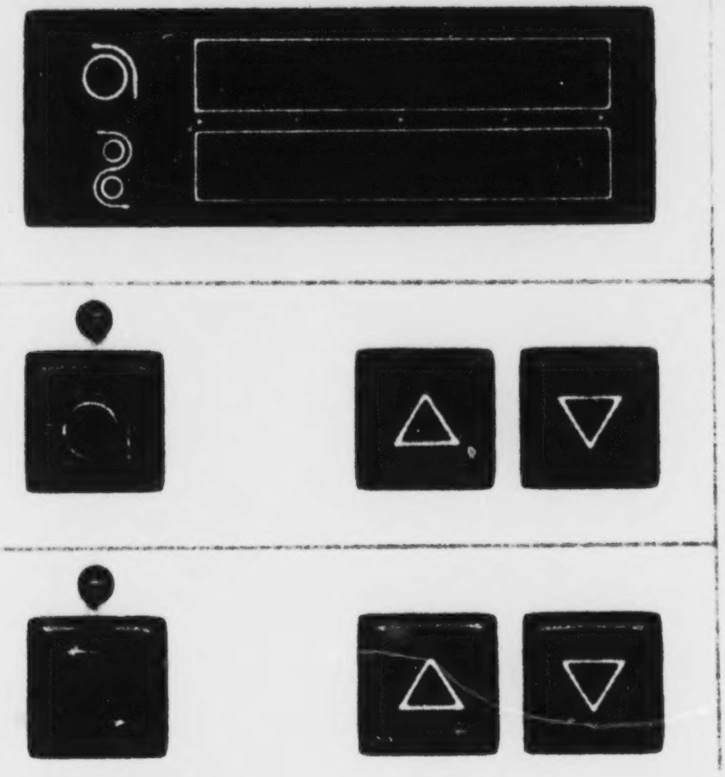
3

X· Y Table Manual Feed Select Key
Pressing this key lights up the lamp and enables XY table movement with the table feed keys.

4

U· V Table Manual Feed Select Key
Pressing this key lights up the lamp and enable UV table movement with the table feed keys.

Feed and Tension Keys

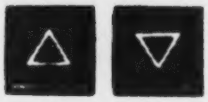


1

Wire Feed Key

Pressing this key lights up the lamp and energizes the wire takeup motor. Pressing it again will turn it off. Wire feed will become inoperative if the wire breakage detecting switch has been off for a given time.

2



Wire Feed Control

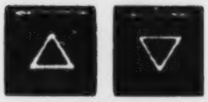
These keys control the wire feed rate: for increase and for decrease. Wire feed rate is displayed on the wire feed rate level meter.

3

Wire Tension Key

Depressing this key lights up the lamp and causes tension onto the wire. Depressing it again will turn key and lamp off. Wire tension will become inoperative if the wire breaks causing the machine to shut down.

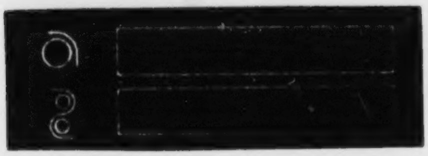
4



Wire Tension Control

These keys adjust the wire tension: for increase and for decrease. Wire tension is displayed on the wire tension level meter.

5



Wire Feed Rate LevelMeter/
Wire Tension Level Meter

Upper LEDs indicate wire feed rate, and lower LEDs wire tension.

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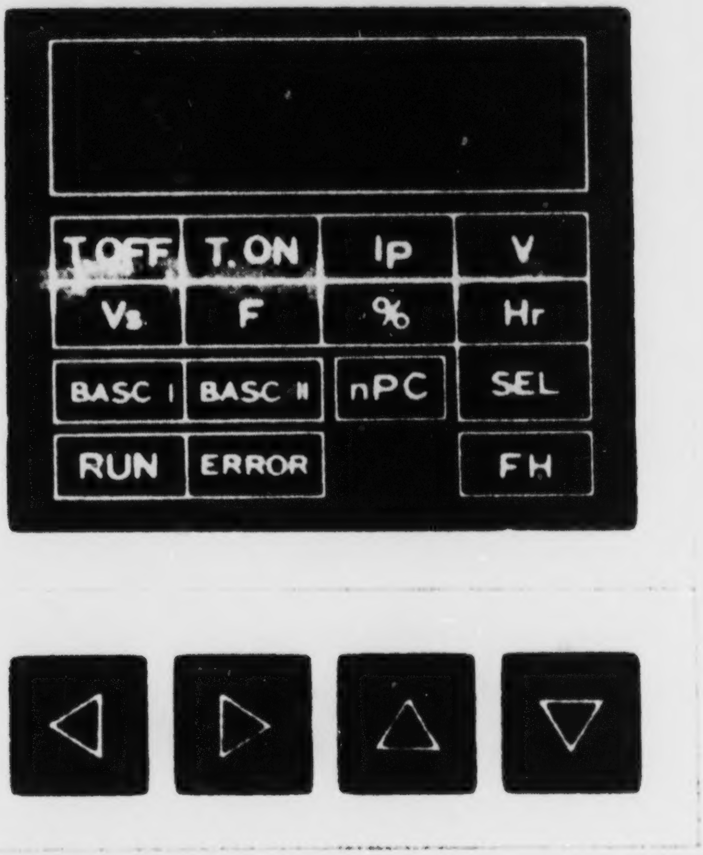
JAPT-3F Setting of Machining Parameters



Machining Parameter Setting Panel (JAPT-3F)

1

Numeric Display
The setting for an item which is indicated by the LED Display is shown.

2 -CHANGES-

LED Display
LED lights to show that an item lit can be set of changed.

3

Setting Item Selection Key (CCW)
Each time this key is pressed, the lit LED will change item by item leftward, in the direction of the arrow. LED stays lighting at "%" while the key is pressed for two times to allow override settings.

4

Setting Item Selection Key (CW)
This key has the same function as "setting item selection" key, except the lit LED function will change item by item rightward.

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5 △ Parameter Setting Increment Key
This key increase a tap number on the numeric display. When SEL is lit, this key can be used to changeover to BASC I and BASC II. When HR is lit, this key resets the accumulated machining time.

6 ▽ Parameter Setting Decrement Key
This key decreases the tap number on the numeric display. When SEL is lit, this key resets can be used to change over to BASC I and BASC II. When Hr is lit, this key resets the accumulated machining time.

7 T ON Pulse Width
Can be changed in steps, 1 to 10. Pulse width increases and peak current gets little higher with larger numbers.

8 T OFF Pulse Off Time
Can be changed in steps, 1 to 10. Pulse off time increases with larger numbers.

9 IP Peak Current
Can be changed in steps, 1 to 14. Peak current in continuous discharge increases with larger numbers.

10 V Machining Voltage
Can be changed in steps, 1 to 9. Load voltage and peak current increase with larger numbers.

11 Vs Servocontrol
Can be changed in steps, 1 to 15. Setting of voltage machining in BASC I and short detecting voltage machining in BASC II can be done.

12 Hr Machining Time
Records accumulated machining time. Use either △ or ▽ key to reset time to 0.

13 F Table Feed Rate
High table feed rate limit under BASC I. The basic table feed rate can be set at 0 through 40 mm/min by 16 steps. The selected table feed rate is shown on the display. Setting of F to 0 will give BASC I the highest allowable table feed rate.

14 % Override
The selected value of F can be compensated from 1 to 199% in steps of 1%. Example: If F is set to 2 mm/min and override to 80%, the table feed rate would be equal to 2 x 0.8 = 1.6 mm/min.

15 SEL Servo Selection
Selects either BASC I or BASC II. When ▷ or ◁ is pushed while this LED is on.

16 BASC I

BASC I
Lights up when BASC I is set for machining. Voltage is changed by adjusting servocontrol.

17 BASC II

BASC II
Lights up when BASC II is set for machining. When this LED is lit, machining rate is constant, based on Vs (Servocontrol), F (Table feed rate) and % (Override).

18 RUN

Run
This LED is lit when automatic hole center and edge finding are in progress.

19 ERROR

Error
This LED lamp lights up under the following conditions and position operation stops:

1) table reaches end of stroke
2) positioning stroke exceeds 50 mm
3) at start of operation, wire is already contacting workpiece.

Erase the LED by pressing Manual key and restart operation after resolving the cause of error. Restart operation must be made from the beginning.

20 FH

Temporary Stop (Feed Hold)
When shorted machining gap exists for more than 5 min., when wire breaks or other wire feed problems exist, this LED lamp and buzzer will come on, and the machine will shut down. When the problem is corrected, reenergize Manual key and the lamp will go out and the buzzer deactivated.

21 nPC

nPC
Set by SEL key when super Finishing Adapter nPC (optional) is attached.

1

Dry Run Key
This is used to check the table movement or the program. When NC OK is shown on the CRT display, pressing this key lights up the lamp and enables the table to move by NC programming in a rapid feed.

2

Cycle Stop Key
Pressing this key will light up the lamp. When machining reaches the program end with this lamp on, power supply will be automatically shut down by the cycle stop function.

3

Manual Machining Key
Pressing this key lights up the lamp and supplys voltage to the machining gap. This function permits minispark positioning on the workpiece. It is also possible to manually machine a piece. However, wire feed and wire tension must be activated and flushing on to permit the operation. By pressing and holding in the axis table feed key needed, the table will move at the rate below.

Item	Selection Key	H/100	M/10	L/1
M.MACH	JOG (mm/min)	30	3	0.3
	STEP (um)	10	5	1

4

Machining Key
Pressing this key lights up the lamp and allows NC machining to begin by application of voltage. Machining can only start if:

1) NC OK is shown on the CRT display.
2) Wire feed is on.
3) Wire tension is on.
4) Flushing is on.

5

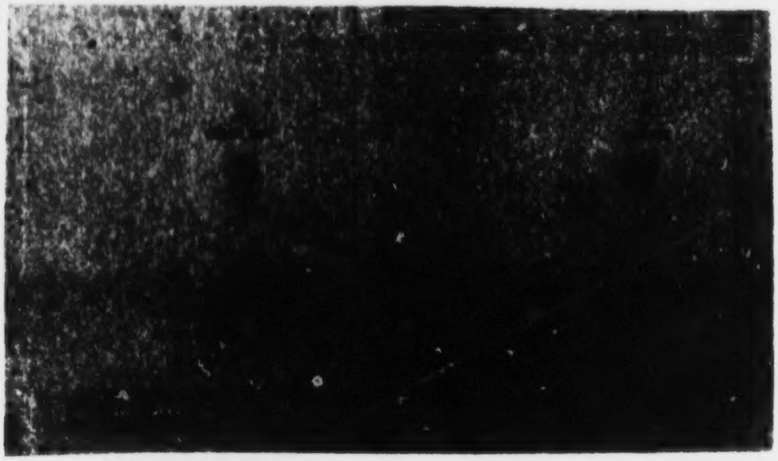
Manual key
Pressing this key lights up the lamp and turns on manual mode. Machining, manual machining, or dry run operation will cease when this key is depressed. Buzzer sounding, due to wire breakage during machining or due to machining end, can be stopped by depressing this key as well.

6

Flush Key
Pressing this key lights up the lamp and starts the flush pump to supply the dielectric fluid to the wire guides. Pressing it again will turn off flushing and light.

Clear-Cut Attachment

1		Power ON/OFF Pushbutton Switch
	-ON-	Press this pushbutton to turn on the CLEAR-CUT attachment. The indicator lamp lights.
2		CLEAR-CUT ON Lamp
	-CLEAR CUT-	This lamp lights to indicate that the CLEAR-CUT attachment is turned on.
3		Alarm Lamp
	-ALARM-	This lamp lights to indicate the CLEAR-CUT attachment is in trouble.
4	-ALARM	Alarm Reset Pushbutton Switch
	RESET-	Press this pushbutton to reset the alarm circuit.
5		Mode Selection Pushbutton Switch
	-NOR.-	This mode gives a constant output to effect constant chip removal.
	-MOD.-	This mode modulates CLEAR-CUT output according to machining gap states.
	-S.C.-	This is selected for skim cut.



CLEAR-CUT Attachment

Notes:

UNIT #15. SPARK INFORMATION AND CUTTING CHARTS

After completion of Unit #15 you will able to:

Identify how EDM spark effects machining.

Adjust and set ON/OFF cutting time.

Adjust and set IP (AMP) settings.

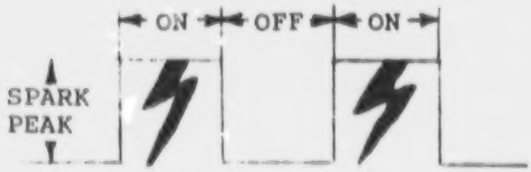
Calculate the overcut of the wire electrode.

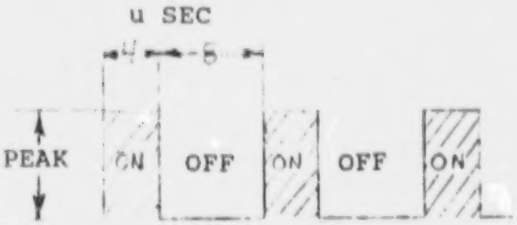
UNIT #15. SPARK INFORMATION AND CUTTING CHARTS

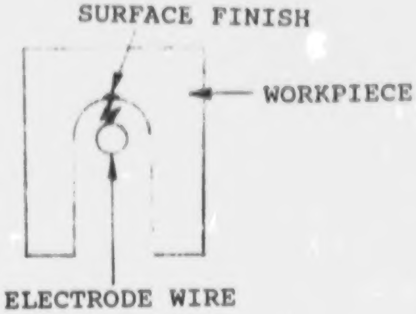
ON and OFF time for Japex Wire EDM

On and off time are controlling factors in determining spark energy. The more spark energy produced the faster the metal will be removed.

DIAGRAM OF EDM SPARKS

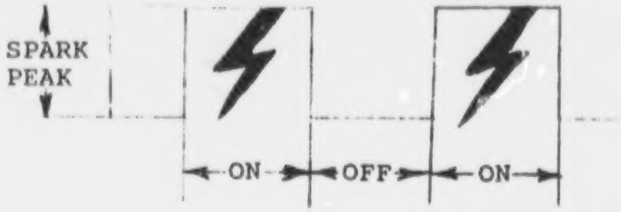

ON
OFF
ON
SPARK PEAK

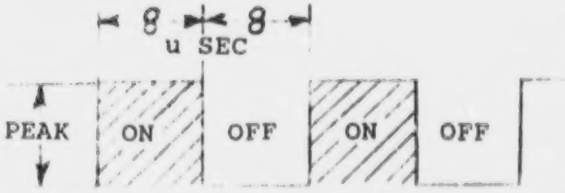

u SEC
4
6
PEAK
ON
OFF
ON
OFF
ON

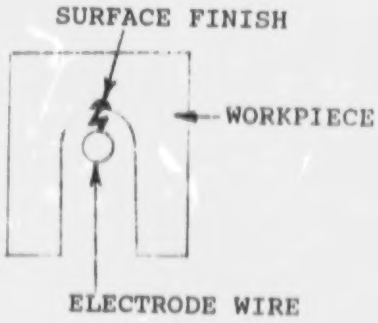

SURFACE FINISH
WORKPIECE
ELECTRODE WIRE

ON TIME TAP = 3 OFF TIME TAP = 2

INCREASE ON-TIME = INCREASE IN SPARK ENERGY = ROUGHER SURFACE FINISH


SPARK PEAK
ON
OFF
ON


8
8
u SEC
PEAK
ON
OFF
ON
OFF


SURFACE FINISH
WORKPIECE
ELECTRODE WIRE

ON TIME TAP = 6 OFF TIME TAP = 2

JAPEX WIRE EDM
SPARK ON-TIME & OFF-TIME CHARTS

OFF CONTROL

CONTROL SETTING	MICRO-SECONDS
1	6
2	8
3	12
4	15
5	20
6	25
7	30
8	35
9	40
10	50

ON CONTROL

CONTROL SETTING	MICRO-SECONDS
1	2
2	3
3	4
4	5
5	6
6	8
7	10
8	12
9	14
10	16

IP = PEAK CURRENT = AMPS

Peak current is the value of maximum spark discharge current when pulse voltage is applied. Peak amperage is also a controlling factor in determining spark energy. The higher the IP setting results in a faster metal removal rate due to the increase in spark energy.

JAPEX WIRE EDM
IP CHART

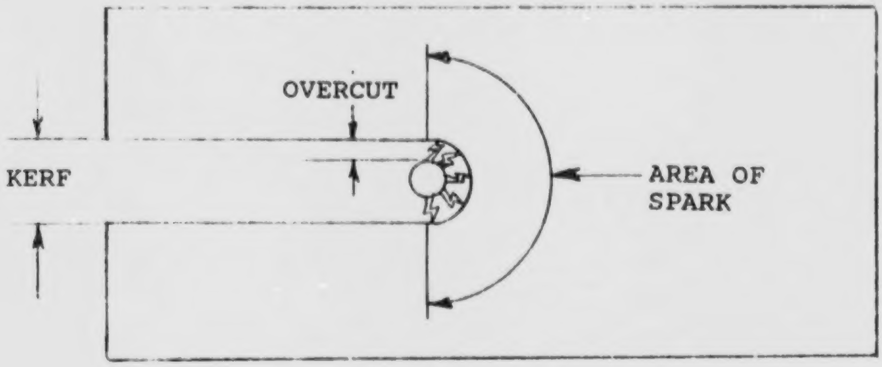
PEAK CONTROL SETTING	PEAK AMPERES
1	0.2
2	0.6
3	1.0
4	1.5
5	2.0
6	2.5
7	3.0
8	4.5
9	6.5
10	8.0
11	9.5
12	12.0

The higher the IP setting, the higher the amps.

Overcut (Kerf)

The slot the wire electrode cuts is always larger than the wire diameter. This slot is called the kerf. There is no contact between the wire electrode and the workpiece taking place. The amount of spark energy applied to the workpiece will determine how large the overcut will be. OVERCUT will usually be approximately .001 to .0015 per side when machining with the JAPEX WIRE EDM.

Example: a .010 diameter wire will burn a kerf approximately .012 to .013 wide.



NOTE: When calculating the wire compensation for a project always remember to add in the overcut from one side only (.001 to .0015).

Notes:

UNIT #16. SQUARING THE WIRE

To familiarize students with the proper setup needed to square the wire.

To be able to select the proper key functions necessary to successfully square the wire.

UNIT #16. SQUARING THE WIRE

The following procedure is used to SQUARE the wire, sometimes referred to as bringing the wire to a vertical position.

When the wire is vertical, the operator can then store this position in the memory of the control.

1. Turn clearcut OFF.

2. Set the power supply for the LOWEST spark energy, and LONGEST time between sparks.

   example:

   On-Time = 1
   Peak (Ip) = 1
   Volt Tap = 1
   Off-Time = 1

3. Turn flushing OFF.

   Wire guides and area around wire guides MUST be completely DRY. Around upper and lower guides and energizing pins and lower energizing roller MUST also be completely DRY.

4. Mount squaring block in machine.

   Mount squaring block (1-2-3 block works good) with sides parallel to X and Y axes. Top should be parallel to XY plane.

5. Turn ON wire speed and wire tension..

6. Manually JOG wire close to the squaring block, and square by eye.

   Square by eye both X-U and Y-V axes.

7. Use the Automatic Edge Finder to get the wire next to the squaring block.

   1) Select LOW JOG speed.

   2) Turn on the Automatic Edge Finder.

   3) Press +X, -X, +Y, or -Y.

   4) Turn OFF the Automatic Edge Finder by pressing either the Manual Mode key, or the Automatic Edge Finding key.

8. Turn ON manual machining.

   Looking to get an even small spark up and down the side of the squaring block.

   Spark should travel top to bottom evenly.

9. Select STEP mode.

10. Select smallest step increment.

11. Select M.TBL.

12. Step X or Y until 50 volts is obtained on the volt meter which is on the front of the power supply cabinet.

    0 volts = too close to squaring block
    80 volts (open voltage) = too far away from squaring block

13. If a spark is only seen at the bottom of the squaring block, this means that the wire is not vertical. The bottom of the wire is closer to the squaring block than the top. If this is the case, do the following, otherwise continue on to step #14.

    1) Select M.TBL.

    2) Step M.TBL AWAY from the squaring block until open voltage is obtained.

    3) Select E.TBL.

    4) Step E.TBL TOWARD the squaring block until 50 volts is obtained.

    5) Visually look at spark and repeat step #13 as necessary.

14. If a spark is only seen at the top of the squaring block, this means that the wire is not vertical. The top of the wire is closer to the squaring block than the bottom. If this is the case, do the following:

    1) Select E.TBL.

    2) Step E.TBL AWAY from the squaring block until open voltage is obtained.

    3) Select M.TBL.

    4) Step M.TBL TOWARD the squaring block until 50 volts is obtained.

    5) Visually look at spark and repeat step #14 as needed.

15. Do step #13 and/or #14 as many times as required to obtain an even spark traveling top to bottom on the squaring block.

16. Turn manual machining OFF. (Press Manual Mode Key.)

17. Select M.TBL.

18. Manually JOG X and/or Y axes to next side of squaring block.

    To insure that the wire is vertical, it is suggested that the operator square the wire to one side of the squaring block (X-axis/U-axis), then do the next side (Y-axis/V-axis), and then repeat the first side (Y-axis/V-axis).

19. Repeat steps #7 through #18 as many times as required to obtain a vertical wire.

20. Once the wire is vertical, zero U and V axes by doing the following:

    1) Select E.TBL.

    2) Press X CLR and Y CLR

    3) Select M.TBL.

    The vertical wire position will be stored in the memory of the control by using the following commands.

    The U and V axes have register in which can be stored the distance from the negative limit switch (left limit switch) for U-axis and the negative limit switch (front limit switch) for V-axis, to the vertical wire position.

21. After the wire is vertical and the U and V axes have been zeroed, do the following:

    1) Select E.TBL.

    2) Select HIGH JOG speed.

    3) Manually jog the U and V axes to their negative limits by pressing -X and -Y buttons at the same time, until the E.LIM light on the control front panel is lit, and both U and V axes have stopped.

    4) Select LOW JOG speed.

    5) Select STEP mode.

    6) Press +X and +Y momentarily one at a time to move the U and V axes off their limit switches, after which the E.LIM light will go out.

    7) Select smallest step increment.

    8) STEP off and then back on each limit switch, one at a time, until the exact location of each is determined.

22. After the U and V axis limit switches are just touched, the values for the U and V axes on the status page are then the distances from the vertical wire position to the limit switches for both U and V axes. These two distances are then stored in the memory of the control by doing the following:

1) Record the two values on a sheet of paper to be kept at the machine. Also record the date and wire guide size.

2) Key in:

19 (STORE) NC Reset and go to Main Menu

3) Key in:

2 (STORE) E.C. SET

Input the U and V values.

The minus sign (-) need not be input for these two values.

Once these two values are stored, they can be seen on the lower right hand side of the status page.

4) Key in:

4 (STORE) E.C. ORG

This will bring the wire back to the vertical position.

5) After the wire is vertical, the values displayed for U and V on the status page should match the E.C. SET values which can be seen on the lower right hand side of the status page.

23. At this point, the U and V axes are to be zeroed by doing the following:

1) Select E.TBL.

2) Press X CLR and Y CLR keys.

3) Select M.TBL. This will insure that the U and V axes are not accidentally moved from the vertical position.

24. If any time the wire is not vertical but is desired to be, using the menu page command 4 - E.C. ORG will return the wire to the vertical position, after having first contacted the limit switches.

NOTES:

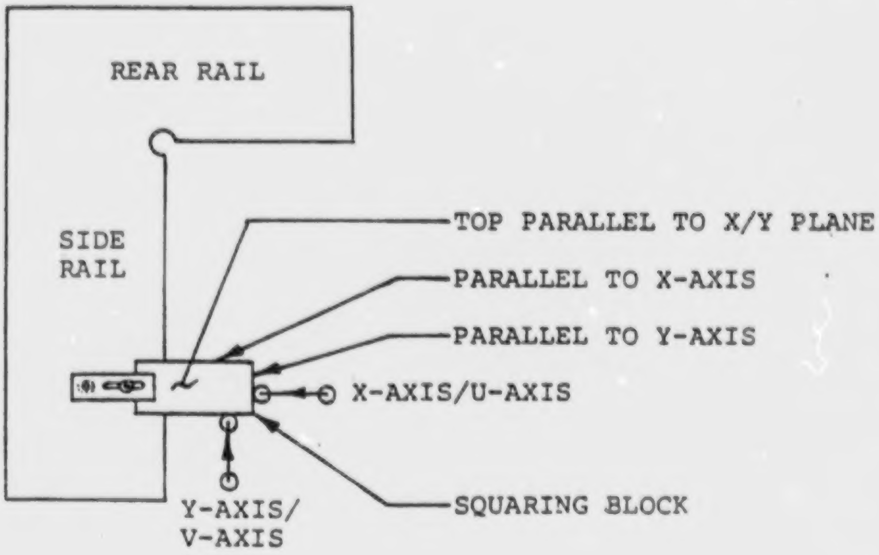
1. The wire must be squared and values stored every time the wire guides are changed.

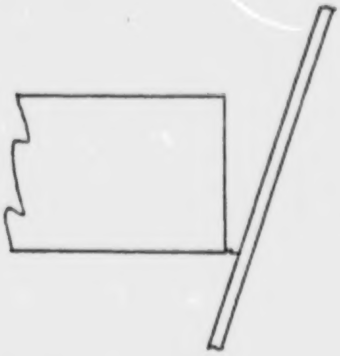
2. The wire should be doubled checked for vertical position prior to running each and every job.

3. For best results, use the same wire speed and wire tension as will be used for cutting, however for good results the wire speed may be reduced to save wire.

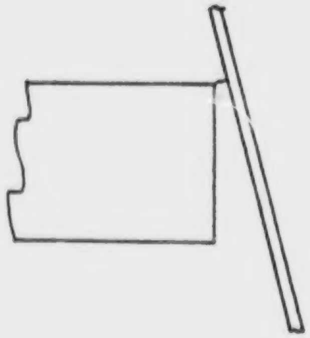
4. Also, for best results, use the same upper arm position as will be used for cutting, if at all possible.

SQUARING THE WIRE

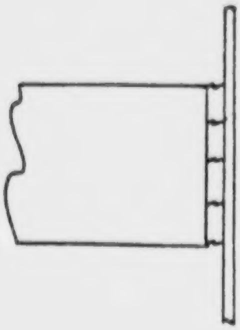

REAR RAIL
SIDE RAIL
TOP PARALLEL TO X/Y PLANE
PARALLEL TO X-AXIS
PARALLEL TO Y-AXIS
X-AXIS/U-AXIS
SQUARING BLOCK
Y-AXIS/ V-AXIS



SPARK ONLY AT BOTTOM



SPARK ONLY AT TOP



EVEN SPARK TOP TO BOTTOM

Notes:

UNIT #17. SET UP AND START POINT LOCATION

After completion of Unit #17 you will able to:

Properly set up a part to be machined onto the machine parallels.

Accurately find a start point location.

Correctly edgefind the edge of the part to be machined.

Correctly centerfind a hole of the part to be machined.

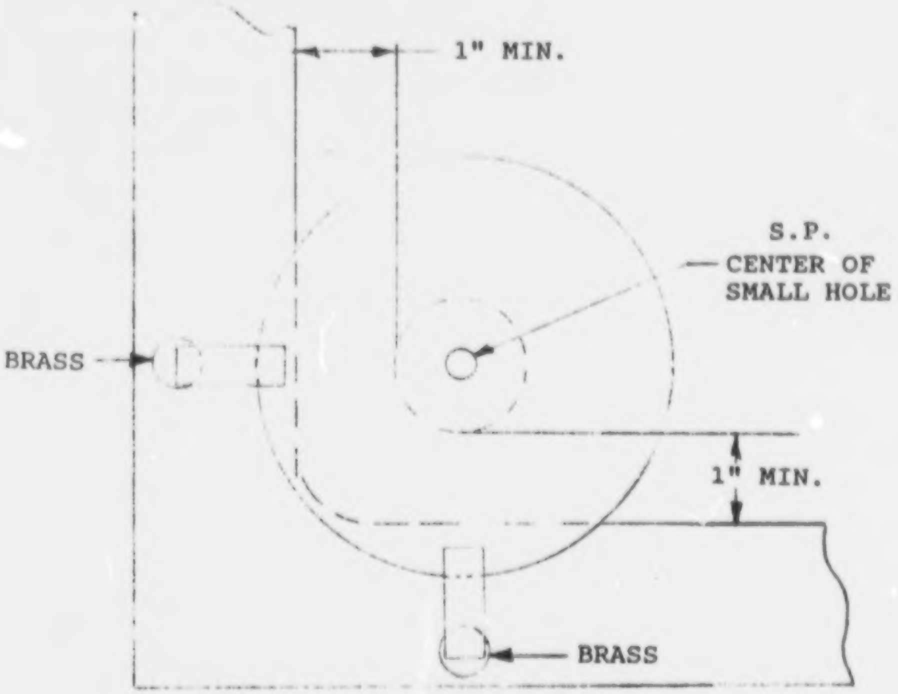
UNIT #17. SET UP AND START POINT LOCATION

Certain guidelines need to be followed on all projects to insure a good setup and machining the part to size. Whether the project to be machined is round, square, rectangle, or irregularly shaped, these guidelines still need to be followed.

Setting up a project onto the machine parallels

Make sure to leave approximately one (1) inch minimum from the edge of the machine parallel to the cutting edge.

To avoid severe damage to the arm there is a safety limit switch that causes the machine to shut down when the arm is approximately one (1) inch away from the parallel.



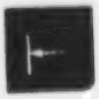
Always have back end of clamps on a piece of brass to protect the machine parallels.

Start Point Location

The starting point (S.P.) on this project is a small hole in the center of the part. The hole will have to be center found to find the exact center of it. This location will be the starting point.

Start Point Location

To edgefind an edge, the part must have good clean surface for most accurate pickup; the best is ground surface.

1. Oil or rust on the surface being edgefound will ease problems.
2. Clear cut should be off when edgefinding.
3. IP should be set to 1.
4. Bring wire to within 1/8" of edge.
5. Set to JOG and L/1.
6. Tension must be on and set on 10.
7. Feed must be on and set on 1.
8. Push  key--red light will come on.
9. Push correct axis key to send wire towards edge to be edgefound.
10. Alarm will beep when edge is correctly found.
11. Turn off alarm by hitting key (hand).
12. Hit (X-clear) and (Y-clear) axis keys to read 0-0.

NOTE: Remember that when positioning to a start point location you must take into consideration 1/2 of the wire diameter.

Example: if the part calls for a 1.000 dimension in from the edge, the program would be 1.000 + .005 = 1.005. That is the dimension from edge plus .005, which is 1/2 of the .010 wire diameter.

To centerfind a hole

The part must have good clean surface for most accurate pickup, best is jig ground hole.

Emery cloth pickup hole to clean up after heat treat, or when dirty, is sometimes acceptable.

Then steps

1. Oil or rust on the surface being edgefound will ease problems.

2. Clear cut should be off when edgefinding.

3. IP should be set to 1.

4. Bring wire to within 1/8" of edge.

5. Set to JOG and L/1.

6. Tension must be on and set on 10.

7. Feed must be on and set on 1.

8. Push ⌖ key--red light will come on.

9. Push any axis key.

10. Alarm will beep when edge is correctly found.

11. Turn off alarm by hitting ■ key (hand).

12. Hit (X-clear) and (Y-clear) axis keys to read 0-0.

13. Push ⌖ key--red light will come on.

14. Push any axis key.

15. Alarm will beep when edge is correctly found.

16. Turn off alarm by hitting ■ key (hand).

17. Hit (X-clear) and (Y-clear) axis keys to read 0-0.

Do not compensate for 1/2 of the wire diameter when starting from the center of a hole.

NOTE: IP should be set to one (1) when edgefinding a hole or an edge.

Notes:

UNIT #18. THE MAIN MENU

After completion of Unit #18 you will able to:

Successuly input a manual program into the CNC control.

Make necessary corrections at the machine control of a previously entered CNC program.

Enter and change taper into the CNC control.

Enter and change wire compensation into the CNC control.

Set up the plotter, dry run and prove out the entered program.

Set up the Japex machining parameters for a rough and skim cut.

UNIT 18. THE MAIN MENU

Entering a program into the CNC control requires understanding certain choices that the main menu offers. Numbers 1 through 6, 11, 14, 15, and 18 are not used to enter a program. Numbers 7, 8, 9, 10, 12, 13, and 19 will be used to enter a program into the CNC control. When selecting a number from the main menu, a conversational menu will appear on the screen.

```
  1  :  MEMORY CALL        2  :  E.C. SET
  3  :  BACK LASH          4  :  E.C. ORG
  5  :  X/Y MIRR.          6  :  M.LOCK
  7  :  B.SKIP(0) E.CHK(0)  O.STOP
  8  :  NC SET            9  :  D SET
 11  :  TAPE READ        10  :  A SET
 13  :  DATA EDIT        12  :  M SET
 15  :  P.D. AUTO (0)    14  :  P SET
 19  :  NC RESET         18  :  NC D.RUN
```

This is the main menu

13 STORE

To manually input a CNC program, select 13 Data Edit from the main menu:

Key in:

(1)(3) for the number 13 and then push the (STORE) key.

This will call up the Data Edit menu. At the bottom of the screen there are 5-different characters to choose from.

```
   DATA EDIT            NO. 001
 >




   (I,P,D,R,/)=
   _
```

(I,P,D,R,/)

I :	Insert	This is used to input a program. Insertions are made ahead of the block with > marker.
P :	Correction	The block with > marker is corrected.

D	:	Delete	The block with > marker is deleted.
R	:	Replace	The word in the block with > marker is replaced by another word.
/	:	Return	Returns to Select Display. (Main Menu)

Input A Sample Program:

Manually input a program to cut a 2.000 ±.0002 square die opening. The start point will be in the center of the 2x2 and one degree slug relief is required. All letters and numbers need to be entered as follows:

Key in:

```
IN  1     G20 (STORE)
IN  2     G90 (STORE)
IN  3     G42 G92 X0 Y0 D01 A01 (STORE)
IN  4     G01 X-1.0 (STORE)
```

Note that after hitting the (STORE) key after line number 4, that line number 5 disappears off the screen. Only three lines of the program can be displayed on the screen at any one time while inputing the program. Five lines will be displayed once the complete program has been entered and stored into memory.

```
IN  5     Y1.0 (STORE)
IN  6     X10.0 (STORE)      Note:  in line number 6, the X10.0
                             is wrong.  It will be corrected
                             later.
IN  7     Y-1.0 (STORE)
IN  8     X-1.0 (STORE)
IN  9     Y0 M01 (STORE)
IN  10    X0 (STORE)
IN  11    M02 (STORE)
```

After line number 11 is entered, to go back to the beginning of the program, key in (1)+(STORE) and the > marker will be on line number 1, the first line of the program. Depress the (STORE) key again and the > marker will be on line number 2. Every time the (STORE) key is depressed each line advances upward by one. In this manner the program can be reviewed line by line for any input errors that may exist.

If an error has been made there are three ways to make the necessary corrections. Which correction method to use would depend upon how much of the line needs to be corrected.

To correct line number 6 of the sample program using:

(P) Correcting a line

Make sure the > marker is on the line to be corrected.

Key in:

PN 6 X1.0 (STORE)   to correct the line that was X10.0.

```
DATA EDIT       No. 006
N0004       G01 X-1.0*
N0005       Y1.0*
>N0006      X10.0*
N0007       Y-1.0*
N0008       X-1.0*

(I,P,D,R,/)=
PN 6 X-1.0 STORE
```

after depressing store
the screen becomes

```
DATA EDIT       No. 007
N0004       G01 X-1.0*
N0005       Y1.0*
N0006       X1.0*
>N0007      Y-1.0*
N0008       X-1.0*

(I,P,D,R,/)=
-
```

(R) Correction made by replacing a portion of a line

Make sure the > marker is on the line which contains the word to be replaced.

Key in:

R X10.0 (SPC) key X1.0 (STORE)

```
DATA EDIT       No. 006
N0004       G01 X-1.0*
N0005       Y1.0*
>N0006      X10.0*
N0007       Y-1.0*
N0008       X-1.0*

(I,P,D,R,/)=
RX 10.0  X1.0 STORE
```

```
DATA EDIT       No. 007
N0004       G01 X-1.0*
N0005       Y1.0*
N0006       X1.0*
>N0007      Y-1.0*
N0008       X-1.0*

(I,P,D,R,/)=
-
```

Now replace D01 in line 3 of the sample program with D02. Make sure > marker is on line 3.

Key in:

R D01 (SPC) key D02 (STORE)

```
DATA EDIT       No. 003
N0001       G20*
N0002       G90*
>N0003      G42 G92 X0 Y0 D01 A01*
N0004       G01 X-1.0*
N0005       Y1.0*

(I,P,D,R,/)=
RD01 D02 STORE
```

```
DATA EDIT       No. 004
N0001       G20*
N0002       G90*
N0003       G42 G92 X0 Y0 D02 A01*
>N0004      G01 X-1.0*
N0005       Y1.0*

(I,P,D,R,/)=
-
```

(D) Deleting an entire line and inserting a new one that is correct

Again make sure the > marker is on line 6.

```
                    DATA EDIT      No. 006
                    N0004      G01 X-1.0*
                    N0005      Y1.0*
                    >N0006     X10.0*
                    N0007      Y-1.0*
                    N0008      X-1.0*

                    (I,P,D,R,/)=
Key in: ----------->D (STORE)
```

After depressing (STORE) key line #6 is deleted, and > moves to line #7.

```
                    DATA EDIT      No. 006
                    N0004      G01 X-1.0*
                    N0005      Y1.0*
                    >N0007     Y-1.0*
                    N0008      X-1.0*
                    N0009      Y0 M01*

                    (I,P,D,R,/)=
Key in: ----------->IN 6 X1.0 (STORE)
```

After depressing (STORE) key line 6 will be inserted before the line that the > marker is on.

corrected line:

```
                    DATA EDIT      No. 007
                    N0004      G01 X-1.0*
                    N0005      Y1.0*
                    N0006      X1.0*
                    >N0007     Y-1.0*
                    N0008      X-1.0*

                    (I,P,D,R,/)=
                    _
```

When the entire program recorded in memory is to be deleted, key in (D9999) (STORE) and the program will be deleted.

When all changes are made and the program is correct key in (/)(STORE) to get back to the main menu.

7 STORE

Now that the program is entered into the CNC control, there is still more information to be entered into other menu selections.

Select (7)(STORE) to set an optional stop. The number 7 menu also has a block skip and an error check function. We will not use either of them.

When Block Skip comes on the screen it gives you the option to say on or off. 1 is on; 0 is off.

```
 1  :  MEMORY CALL         2  :  E.C. SET
 3  :  BACK LASH           4  :  E.C. ORG
 5  :  X/Y MIRR.           6  :  M.LOCK
 7  :  B.SKIP(0) E.CHK(0) 0.STOP
 8  :  NC SET              9  :  D SET
11  :  TAPE READ          10  :  A SET
13  :  DATA EDIT          12  :  M SET
15  :  P.D. AUTO (0)      14  :  P SET
19  :  NC RESET           18  :  NC D.RUN
     =  7
 BLOCK SKIP (1/0)_
```

Select OFF (0) for Block Skip.

Next Error Check will appear on the screen.

```
 1  :  MEMORY CALL         2  :  E.C. SET
 3  :  BACK LASH           4  :  E.C. ORG
 5  :  X/Y MIRR.           6  :  M.LOCK
 7  :  B.SKIP(0) E.CHK(1) 0.STOP
 8  :  NC SET              9  :  D SET
11  :  TAPE READ          10  :  A SET
13  :  DATA EDIT          12  :  M SET
15  :  P.D. AUTO (0)      14  :  P SET
19  :  NC RESET           18  :  NC D.RUN
     =  7
 ERROR CHECK (1/0)_
```

Select OFF (0) for Error Check.

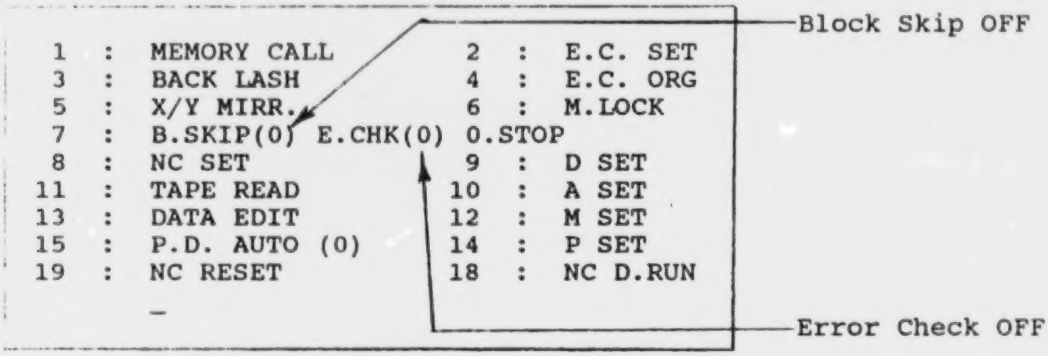
Next Optional Stop will appear on the screen.

```
  1  :  MEMORY CALL        2  :  E.C. SET
  3  :  BACK LASH          4  :  E.C. ORG
  5  :  X/Y MIRR.          6  :  M.LOCK
  7  :  B.SKIP(0) E.CHK(0) 0.STOP
  8  :  NC SET             9  :  D SET
 11  :  TAPE READ         10  :  A SET
 13  :  DATA EDIT         12  :  M SET
 15  :  P.D. AUTO (0)     14  :  P SET
 19  :  NC RESET          18  :  NC D.RUN
     =  7
 OPT. STOP (1/0)_
```

Select one (1) for yes.

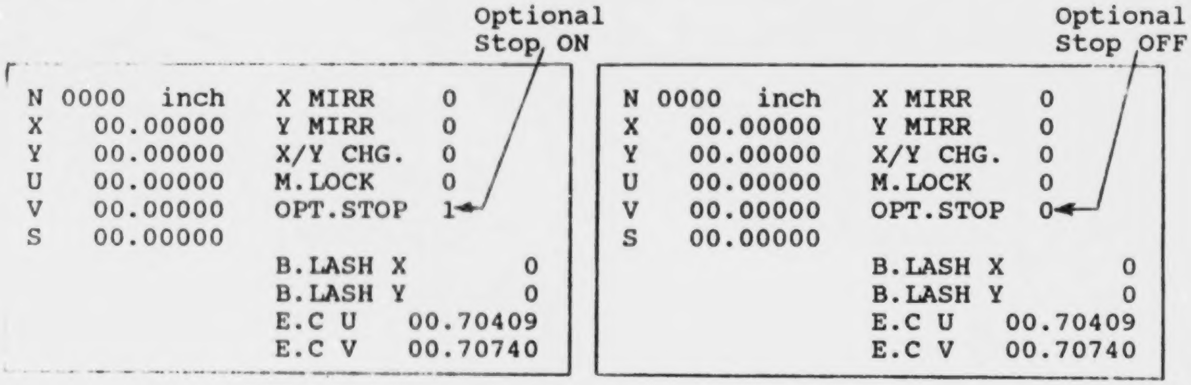
An optional stop is needed at the end of line number 9 (that is the M01) to remove the slug from the part we are cutting.

After these selections are completed key in a (/) and (STORE) and this will return to the main menu. Selection of Block Skip and Error Check are always displayed on the main menu.



```
  1  :  MEMORY CALL        2  :  E.C. SET
  3  :  BACK LASH          4  :  E.C. ORG
  5  :  X/Y MIRR.          6  :  M.LOCK
  7  :  B.SKIP(0) E.CHK(0) 0.STOP
  8  :  NC SET             9  :  D SET
 11  :  TAPE READ         10  :  A SET
 13  :  DATA EDIT         12  :  M SET
 15  :  P.D. AUTO (0)     14  :  P SET
 19  :  NC RESET          18  :  NC D.RUN
        _
```

Optional Stop is always displayed on the status display as 0 or 1.



```
N 0000   inch    X MIRR     0
X   00.00000     Y MIRR     0
Y   00.00000     X/Y CHG.   0
U   00.00000     M.LOCK     0
V   00.00000     OPT.STOP   1
S   00.00000
                 B.LASH X         0
                 B.LASH Y         0
                 E.C U    00.70409
                 E.C V    00.70740
```

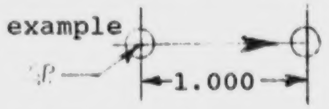
```
N 0000   inch    X MIRR     0
X   00.00000     Y MIRR     0
Y   00.00000     X/Y CHG.   0
U   00.00000     M.LOCK     0
V   00.00000     OPT.STOP   0
S   00.00000
                 B.LASH X         0
                 B.LASH Y         0
                 E.C U    00.70409
                 E.C V    00.70740
```

9 STORE

The 2.000 inch Square die opening that will be cut needs a rough and finish cut to hold the size on the print. The quickest and most efficient way to accomplish this is just change the D set amount in the number 9 register when machining the rough and finish cuts.

A good rough cut wire compensation to enter is .0078. Compensation .0078 can also be used for the first cut if using Taper to cut an angle onto the piece for slug clearance.

Now remember that using a .010 diameter wire that is programed to go out to finish size will burn the die opening to big.



.005 of wire is already past the edge of the programed part

Also remember to compensate for the overcut of .001 to .0015 per side for computing the wire compensation value. This is how the .0078 value for the rough or taper wire compensation was figured.

Select (9)(STORE) and the screen will come up as below

```
        D SET              (inch)

  D01                .00000
  D02                .00000
  D03                .00000
  D04                .00000
  D05                .00000
  D06                .00000
  D07                .00000
  D08                .00000
  D09                .00000

  fmt   :  xx.xxxxxDnn
  /  :  return   90  :  CLEAR
        =
```

Key in a .0078 D01 (STORE) and the screen will look like this

```
        D SET              (inch)

  D01                .00780
  D02                .00000
  D03                .00000
  D04                .00000
  D05                .00000
  D06                .00000
  D07                .00000
  D08                .00000
  D09                .00000

  fmt   :  xx.xxxxxDnn
  /  :  return   90  :  CLEAR
        =
```

Keying in a

    (9) (STORE)

will clear all data recorded in D01 through D09.

Keying in

    (/) (STORE)

will return you to the main menu

Note:
D Set is modal. Its compensated value stays the same unless deleted or changed.

TAPER

Japax calls their taper feature "EDGECUT". Taper is accomplished via two upper axes which are parallel to X and Y axes.

These two upper axes are referred to as the edgecut table (E.TBL).

U is parallel to X
V is parallel to Y

X and Y axes are referred to as the main table (M.TBL).

The Japax control uses the sine of the required angle to calculate how much to offset each axis and in what direction.

Thus, for one (1) degree taper, you would use a sine of 0.01746. Two degrees would be 0.03492. Five degrees would be 0.08749.

If a taper is needed it has to be entered into the number 10 register. In the 2.000 x 2.000 square sample program on line number 3 taper is called for (A01).

1. Determination of what angle (in degrees) is needed would come from the part that is being cut.
2. If the taper to be cut is one degree, the sine of one degree is then set into the A register.
3. The die life is at the top of the die block so a (-) value for one degree is entered.
4. To use taper, a G41 or G42 must be in the NC program even if wire compensation is not used to machine the part. (See line number 3 of the sample program.)

Note:

A plus (+) gradient = LEFT TILT
(1 DEGREE LEFT = .01746) DIE LIFE is left on the bottom of die block
A minus (-) gradient = RIGHT TILT
(2 degree right = -.03493) DIE LIFE is left on the top of the die block

To manually load a taper into the machine control

Select (1)(0) (STORE)

Key in: -.01746 A01 (STORE)

for a one degree taper.

```
     GRADIENT
     NORMAL                        LINEAR
A01      -.01746          A21          .00000
A02       .00000          A22          .00000
A03       .00000          A23          .00000
A04       .00000          A24          .00000
A05       .00000          A25          .00000
A06       .00000          A26          .00000
A07       .00000          A27          .00000
A08       .00000          A28          .00000
A09       .00000          A29          .00000

fmt  :  x.xxxxxAnn
/  :  return  90  :  CLEAR
     =
```

input format

Key in: .03492 A01 (STORE)

if a two degree taper is required.

```
     GRADIENT
     NORMAL                        LINEAR
A01       .03492          A21          .00000
A02       .00000          A22          .00000
A03       .00000          A23          .00000
A04       .00000          A24          .00000
A05       .00000          A25          .00000
A06       .00000          A26          .00000
A07       .00000          A27          .00000
A08       .00000          A28          .00000
A09       .00000          A29          .00000

fmt  :  x.xxxxxAnn
/  :  return  90  :  CLEAR
     =
```

input format

Key in: 90 (STORE)

Clears A1 through A9.

Key in: (/) (STORE)

will return to the main menu.

12-M Set

The control needs to know the distance between the wire guides to determine how much to offset the upper axes. This dimension is referred to as the guide span (G).

The control then needs to know the distance between the work table and the lower guide to determine how much to offset the lower axes. This dimension is referred to as the work table height (H).

The control then needs to know the maximum stroke of the E.C. axes (U and V) to know if it can obtain the requested angle. This dimension is referred to as the E.C. table stroke (S).

The G and H values normally do not change once determined for each set of guides which are installed and not changed.

When guides are changed or replaced, the G and H valves should be double checked to insure their accuracy.

In order for the control to calculate where to move the upper and lower wire guides to obtain the required tilt angle on the workpiece, the machine operator must tell the control where the upper and lower guides are in relation to the workpiece.

There are 5 distances (values) which the control must have in order to obtain the required taper.

1. Upper Arm Position
2. Additional Work Table Height
3. Guide Span (G)
4. Work Table Height (H) Machine Tool Data (MTD)
5. Edge Cut Table Stroke (S)

Items #3, #4 and #5 above usually will not change once a set of wire guides is installed in the machine and not disturbed.

Items #1 and #2 will usually change for each workpiece.

These 5 values are sometimes referred to as MACHINE CONSTANTS.

Upper Arm Position: This value changes.
This reading is taken from a mm scale on the upper head when it is set just above the part piece.
example: 30 mm = 1.180

Add Work Table Height: This value changes.
Part thickness minus land thickness.
example: 1.000 - .200 = .800

Guide Span: is a constant .861.

Work Table: is a constant .415.

E-Cut Table Stroke: is a constant .700.

Guide Span, Work Table an dE-cut constants are calculated or our machine set up with .010 wire guides. different guides or machines would have to be recalculated.

To manually load these registers:

Select (12) and (STORE)

```
     MACHINE GUIDE SET         (inch)

*Upper Arm Position            .00000     Upper slide position
 Add Work Table Height         .00000     Add work table height A
 INITIAL GUIDE SET
 GUIDE SPAN (minimum)          .00000     Guide span G
 WORK TABLE (minimum)          .00000     Lower wire guide to
 E-CUT Table Stroke            .00000     work table distance H
                                          EDGE-CUT table stroke S

fmt  :  xx.xxxxx  /  :  return
     = _
```

Enter the values for the asterisked items successively.

Key in: (1.180) (STORE)

and the asterisk will move down to the next line.

Key in: (.800) (STORE)

Key in: (.861) (STORE)

Key in: (.415) (STORE)

Key in: (.700) (STORE)

Key in: (/) (STORE) Returns to MAIN MENU

8 NC Set

The last selection from the main menu that has to be entered is number 8 NC set. This is used to call up and execute a NC program from the CNC machine memory.

Select (8) (STORE)

The three choices are:

RAM:0 --- Random Access Memory	(Computer in the machine)	
PTR:1 --- Paper Tape Reader	(We do not have one)	(EZ-CAM)
CMT:2 --- Cassette Magnetic Tape	(Not used very often)	

```
  1  :  MEMORY CALL        2  :  E.C. SET
  3  :  BACK LASH          4  :  E.C. ORG
  5  :  X/Y MIRR.          6  :  M.LOCK
  7  :  B.SKIP(0) E.CHK(0) 0.STOP
  8  :  NC SET             9  :  D SET
 11  :  TAPE READ         10  :  A SET
 13  :  DATA EDIT         12  :  M SET
 15  :  P.D. AUTO (0)     14  :  P SET
 19  :  NC RESET          18  :  NC D.RUN
     =  8
 RAM : 0    PTR : 1    CMT  : 2  _
```

Key in: (0) (STORE)

for selection of RAM the screen will look like this

```
  1  :  MEMORY CALL        2  :  E.C. SET
  3  :  BACK LASH          4  :  E.C. ORG
  5  :  X/Y MIRR.          6  :  M.LOCK
  7  :  B.SKIP(0) E.CHK(0) 0.STOP
  8  :  NC SET             9  :  D SET
 11  :  TAPE READ         10  :  A SET
 13  :  DATA EDIT         12  :  M SET
 15  :  P.D. AUTO (0)     14  :  P SET
 19  :  NC RESET          18  :  NC D.RUN
     =  8
 RAM : 0    PTR : 1    CMT  : 2  0

 START POINT DISPLAY (1/0) _
```

If Start Point Display (SPD), is required, (G92 line 15), key in:

(1) (STORE)

If Start Point Display is not required, key in:

(0) (STORE)

Answering Start Point Display with a (1) (STORE)

NC OK   will appear on the screen
X position will read 0.0000
Y position will read 0.0000
OPT. STOP position will read 1

```
N 0004  inch          X MIRR    0
X   00.00000          Y MIRR    0
Y   00.00000          X/Y CHG.  0
U   00.00000          M.LOCK    0
V   00.00000          OPT.STOP  1
S   00.00000
NC OK                 B.LASH X         0
                      B.LASH Y         0
                      E.C U     00.70409
                      E.C V     00.70740

                      BLOCK NO.     0001
```

It is now possible to execute Dry Run or NC Machine. The plotter on the machine should be set before executing Dry Run. this will draw the shape of the programmed part for verification before the actual machining of the part piece.

Dry Run and plot is an opportunity to make sure:

1. The NC program is correct (visually check the shape.
2. The taper is turned on to machine the part (if needed).
3. The taper is turned off at the end of the NC program.
4. The optional stop is executed in the proper sequence.
5. To correct any mistakes before the machining the part.

After executing Dry Run, NC END will be on the screen.

```
N 0001  inch          X MIRR    0
X 00.00000            Y MIRR    0
Y 00.00000            X/Y CHG.  0
U 00.00000            M.LOCK    0
V 00.00000            OPT.STOP  1
S 00.00000
NC END                B.LASH X         0
                      B.LASH Y         0
                      E.C U     00.70409
                      E.C V     00.70740

                      BLOCK NO.     0001
                                     M02
```

You must key in

(1)(9) (STORE)	NC Reset; returns to main menu
(8) STORE)	NC Set
(0) (STORE)	RAM
(1) (STORE)	Start Point Display

this prepares the machine to be able to execute NC Run.

NC Run

In NC Run the piece part is actually machined. There are a number of steps that must be followed before you can execute NC Run. These steps should be followed on all of the projects that will be machined on the wire EDM.

After you have reset the machine:

1. make sure to be at the start point of the program

2. reset the hour meter

3. adjust the upper head until the upper flush ports are approximately 0.100 above the top of the workpiece

4. be sure splash guards are in place

5. turn on flushing and adjust to desired flow

6. make sure wire feed is on

7. make sure wire tension is on

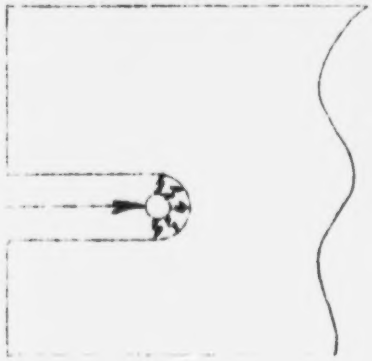
8. make sure clear cut is on

Machining

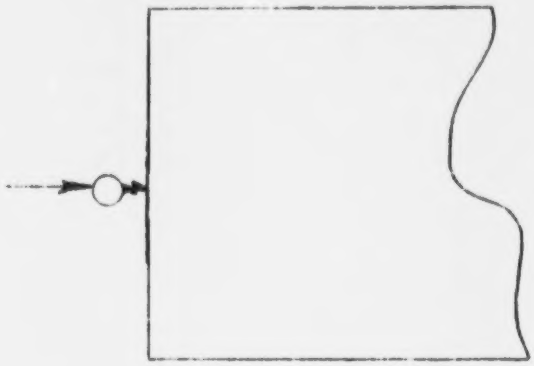
To start machining from the edge of a workpiece, the operator must do three things.

1. Lower PEAK (Ip) to approximately 50% of full cut PEAK.

   The reason is because the wire will only touch at one point rather than 180 degrees, thus too much current density.



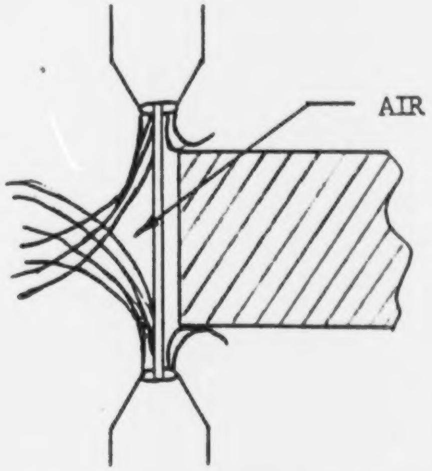
FULL CUT = 180 DEGREES OF SPARKING AREA.



STARTING IN FROM EDGE = SMALL SPARKING AREA AND HIGH CURRENT DENSITY.

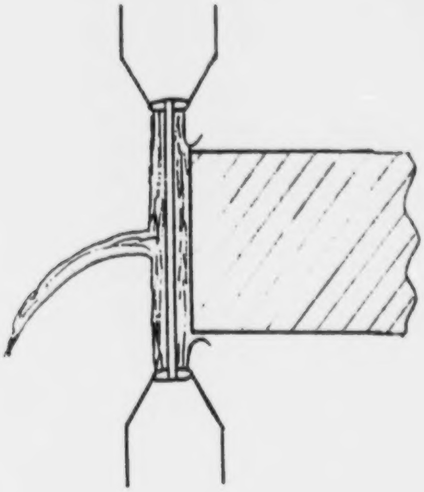
2. Lower flush, to a slow rate, with an umbrella in the center of the workpiece.

   Too fast of flush will cause air to get at the wire near the center of the workpiece because water will splash away.



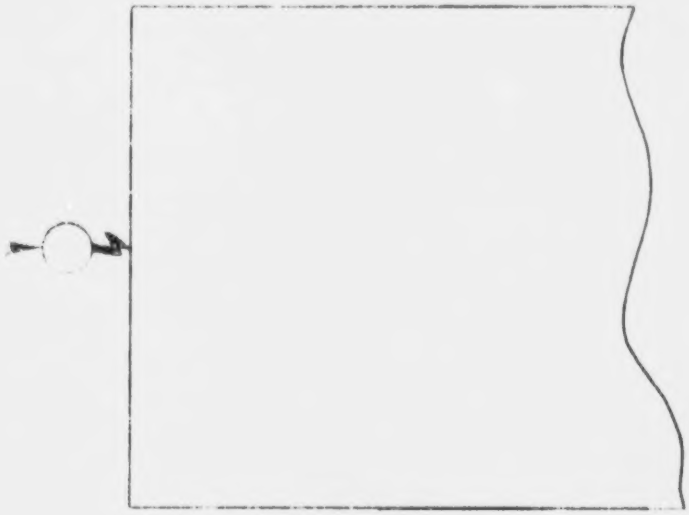
TOO MUCH PRESSURE FOR FLUSH = WILL SPLASH AWAY AND ALLOW AIR TO GET AT WIRE CAUSING WIRE TO BREAK.

Slow flush will allow capillary action to keep water surrounding the wire.



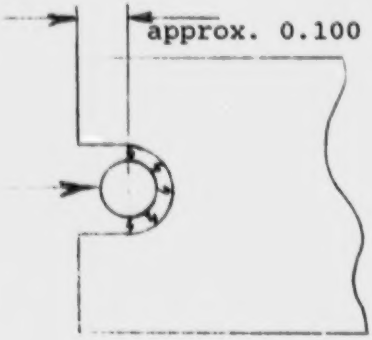
SLOW FLUSH USING UMBRELLA KEEPS WIRE COMPLETELY SURROUNDED BY WATER, THUS NO WIRE BREAKAGE.

3. Set VS, machining voltage tap # to 5. This will act as a break under BASC I.



START MACHINING FROM EDGE WITH 40% PEAK AND SLOW FLUSH

Once into workpiece approximately 0.100, back pressure in slot will keep flush around wire.



ONCE IN APPROXIMATELY 0.100 YOU
CAN INCREASE FLUSH PRESSURE PEAK.

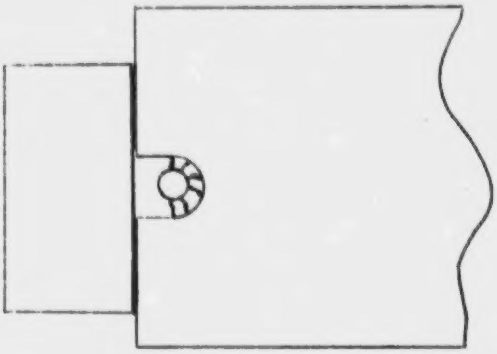
At this point, turn up flush pressure to:

6 kg/cm^2 - top
6 kg/cm^2 - bottom

NOTE: These settings are typical for a 1" thick workpiece.

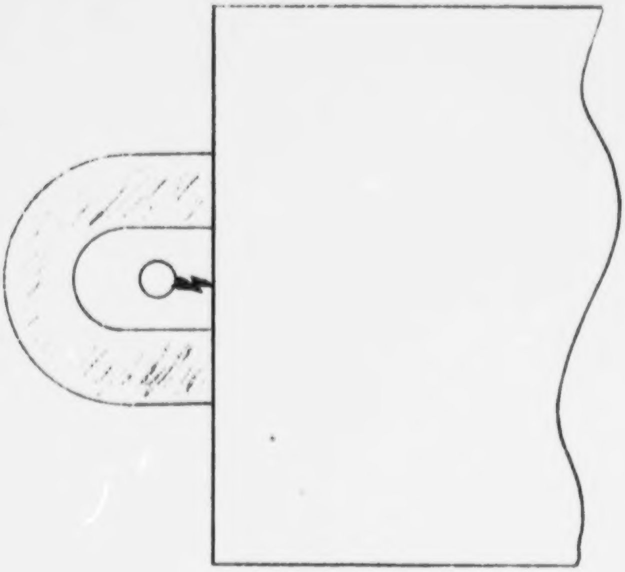
Then increase power settings.

A hint to keep from having to wait for the wire to get in 0.100 is to put a magnet or another piece of stock or sometimes tape over the slot which is being cut by the wire just as soon as the wire is inside the workpiece edge. Then increase flush pressure and peak.



TO AVOID WAITING FOR 0.100, PLACE A
MAGNET OR ANOTHER PIECE OF STOCK
NEXT TO WORKPIECE JUST AS SOON AS WIRE
COMPLETELY ENTERS THE WORKPIECE. THEN
TURN UP FLUSH PRESSURE AND PEAK.

Another hint is to use a magnet or another piece of stock with a groove in it to contain the flush when starting in from the edge of a workpiece.



POSSIBLY USE A MAGNET OR ANOTHER PIECE OF STOCK WITH A GROOVE IN IT TO CONTAIN THE FLUSH WHEN STARTING IN FROM THE EDGE OF A WORKPIECE.

Power Settings

1. Adjust power settings for the start cut Approximately

   T OFF = 2
   T ON = 5
   IP = 5
   V = 4
   VS = 5
   F = 30
   % = 30

2. Press NC machine key

   After the wire cuts into the piece for approximately 0.100 thousandths of an inch, the power setting can be increased or decreased to provide better machining of the part.

3. First cut can also be called a rough cut or taper cut.

   These charts were developed from information logged on different projects in our Tool & Die program for the Japex Wire EDM. These power settings are a good full power cut for different types of steel and various thickness. Experimentation for a faster cutting speeds are encouraged, just log the information onto set up sheets provided and notify the instruction.

MATERIAL	T-OFF	T-ON	IP	V	VS	F	%	S
1/4 CRS	1	9	10	2	3	80	100	.240
1/2 CRS	1	10	10	4	2	80	50	.135
3/4 CRS	1	10	9	3	4	40	90	.100
1 1/2 CRS	1	8	9	3	3	30	60	.040
1" 01	1	10	10	4	1	80	45	.100
1/4 SS	1	10	5	3	1	100	90	.200
1/2 SS	2	8	7	3	4	35	90	.100

4. After the piece is finished key in another (1)(9) (STORE). This will bring up the main menu.

The 7, 9, and 10 registers must be changed at this time.

1. The optional stop should be removed so that on the finish cut the wire does not stop.

2. The amount of wire compensation should be changed to .0056 for the skim cut.

3. The taper should be turned off in the number 10 register for the finish cut.

4. Key in (7) (STORE)
   (0) (STORE)
   (0) (STORE)
   (0) (STORE) OPTIONAL STOP OFF

   (/) (STORE) return to main menu

5. Key in (9) (STORE)
   (.0056 D01)(STORE) changes wire compensation in D01 register from ..0078 to .0056
   (/) (STORE) return to main menu

6. Key in (1)(0) (STORE)
   (.0000 A01)(STORE) changes one degree taper in A01 register to no taper
   (/) (STORE) return to main menu

Skim cutting is a finish cut or cuts taken on the part to insure part print size. These cuts can be controlled to hold sizes of .0001 of an inch if needed. The three main reasons to skim cut are:

1. better surface finish
2. improved corner detail
3. improved accuracy

Skim Cutting Techniques for the Japax Wire EDM

How to determine the number of cuts needed: Tolerance, time, surface finish required, cost and experience will determine the # of cuts needed to hold part print specifications. The rule of thumb is, the closer the tolerance, the more cuts needed.

The following information is a guide on how to approach skim cutting. As with other wire EDM machines, there are no hard and fast rules for the best skim cutting procedure. This is due to variation in the thickness and type of material. The following information is for 1.0 inch thick 01 steel using 0.010" diameter wire. Water conductivity is set at 300 micro amps.

EXAMPLE OF MACHINE SETTINGS

	WIRE/COMP CHANGE	ON	OFF	IP	V	VS	F	%	W/S	W/T
First cut	--------	---	----	----- AS NEEDED-----				----	----	-----
First skim	.0022"	3	3	3-4	3	4	4.0	100	5	12
Second skim	.0008"	2	2	2-3	2	4	4.0	150	3	15
Third skim	.0004"	1	1	5-7	5-7	4	8.0	100	3	17
Fourth skim	.0002"	1	1	3-4	3-4	3	8.0	100	3	18
Fifth skim	.0001"	1	1	2	2	3	8.0	100	1	20

These settings are only a guideline and will vary slightly with different materials and thicknesses. Thicker materials may need slightly more energy. To obtain the best possible surface finish, all the settings must be reduced gradually over several skim cuts.

VS (servo voltage): This is the machining voltage adjustment when using BASC I. By lowering the number (crowding down the machining voltage), the speed will increase. A good voltage to run at is between 60-65 V.

V (Machining Voltage): The no-load voltage decreases when the numbers are reduced.

Ip (Peak Current): By lowering the Ip numbers, the peak current decreases. This helps to obtain a good surface finish.

ONT (on time): This is the major factor influencing the surface finish. The less on time used, the better the surface finish produced. A low number is required, i.e., 1, to obtain a good surface finish on workpiece.

Wire Compensation: the machine is capable of taking as little wire compensation change as .0001" accurately. By adjusting the wire compensation in a set way, an accurate part with a good surface finish can be produced. Recommended wire compensation changes for skim cutting are:

1st skim adjust by .0022" less
2nd skim adjust by .0008" less
3rd skim adjust by .0004" less
4th skim adjust by .0002" less
5th skim adjust by .0001" less

By adjusting the wire tension difference between a rough cut and a skim cut can be adjusted quire dramatically. During the rough cut, high power settings are used thus a low wire tension is needed to not break the wire. during a skim cut, lower power settings are used so a lot more tension can be added to the wire. This also gives more accurate straightness in the part. For a rough cut, 7 or 8 taps on the display is adequate. On the second pass (1st skim), 12 or 13 taps can be used. Then for each additional skim a little more can be added, usually one or two taps above the previous skim.

Wire Feed: the wire feed can be adjusted quite a lot between a rough cut and a skim cut. The wire feed depends upon the power used and the material thickness. By watching where the wire comes out from the bottom of the workpiece and the take up spool, the operator can determine how much wire speed is needed. k If the wire is dark in color and brittle, then more wire speed is required. When skim cutting, the wire speed can be reduced because of the decrease in power used and less material being removed.

Wire: The wire recommended for skim cutting is the SCH (hard brass) wire. It will give good results on surface finish and is also best for the higher tension needed to produce a straight part.

The different diameters of wire, 0.012", 0.010", 0.008", will all use very similar machine settings for skim cuts due to the small amounts of material being removed.

Lines on the Surface Finish: One of the main problems--lines on the workpiece--can be caused by skim cutting too fast. Although the skim cuts can be made to go very fast across the surface of the workpiece, it is advisable to hold back the cutting rate. This can be done by setting the feed rate (F) and percent (%) to hold back the machines cutting speed.

Summary

As the operator becomes more familiar with the machine, the power settings and the skim cuttings procedures, then very good surface finishes can be obtained on all types and thicknesses of materials. The operator will also be able to produce very accurate details on all materials and part thicknesses. Also the number of skim cuts required to obtain an acceptable surface finish will probably be reduced with experience.

Notes:

APPENDIX

G CODES

PREP FUNCTIONS

		FAMILY		
	G00	A		Rapid Positioning-Straight Line
	G01	A	(default)	Cut-Straight Line
	G02	A		Cut Circle CW
	G03	A		Cut Circle CCW
*NON-MODAL	G04			Dwell (used with X2.3 format)
	G20	B		Inch Programmed Values
	G21	B	(default)	Metric Programmed Values
*NON-MODAL	G27			Program Repeat
	G40	C	(default)	Wire Comp - Off
	G41	C		Wire Comp - Left
	G42	C		Wire Comp - Right
	G90	D		Absolute Programming
	G91	D		Incremental Programming
*NON-MODAL	G92			Absolute Position Preset (Start Point)

* All G-Codes are MODAL except as noted.

M CODES

M00	Program Stop	Happens Last (P.STP)
M01	Optional Stop (Glue Stop)	Happens Last (O.STP)
M02	End of Program	Happens Last (NC END)
M29	Shut down	Happens When Read.

e.g., N0019 X-- Y-- (M29) (M00) (M01) or (M02)

will shut down the machine

M01 Will only be honored if the optional stop feature is turned on at the CNC panel.

M29 Will only be honored if the cycle stop light is lit on the 3F front panel.

(Refer to p. 15-2)

JAPEX WIRE EDM
SPARK ON-TIME & OFF-TIME CHARTS

OFF CONTROL

CONTROL SETTING	MICRO-SECONDS
1	6
2	8
3	12
4	15
5	20
6	25
7	30
8	35
9	40
10	50

ON CONTROL

CONTROL SETTING	MICRO-SECONDS
1	2
2	3
3	4
4	5
5	6
6	8
7	10
8	12
9	14
10	16

(Refer to p. 15-3)

JAPEX WIRE EDM
IP CHART

PEAK CONTROL SETTING	PEAK AMPERES
1	0.2
2	0.6
3	1.0
4	1.5
5	2.0
6	2.5
7	3.0
8	4.5
9	6.5
10	8.0
11	9.5
12	12.0

(Refer to p. 14-10)

Table Feed Rate/Step Length Selection Key

Item	Selection Key	H/100	M/10	L/1
JOG (mm/min)	M.TABL E.TABL	600 60	180 30	60 15
STEP (um)	M.TABL E.TABL	100	10	1

(Refer to p. 14-17)

Manual Machining Key

Item / Selection Key		H/100	M/10	L/1
M.MACH	JOG (mm/min)	30	3	0.3
	STEP (um)	10	5	1

(Refer to p. 18-20)

START CUT POWER SETTINGS

FULL CUT POWER SETTINGS

MATERIAL	T-OFF	T-ON	IP	V	VS	F	%	S
1/4 CRS	1	9	10	2	3	80	100	.240
1/2 CRS	1	10	10	4	2	80	50	.135
3/4 CRS	1	10	9	3	4	40	90	.100
1 1/2 CRS	1	8	9	3	3	30	60	.040
1" 01	1	10	10	4	1	80	45	.100
1/4 SS	1	10	5	3	1	100	90	.200
1/2 SS	2	8	7	3	4	35	90	.100

(Refer to p. 18-22)

SKIM CUT POWER SETTINGS

	WIRE/COMP CHANGE	ON	OFF	IP	V	VS	F	%	W/S	W/T
First cut	--------	---	----	----- AS NEEDED-----				----	----	-----
First skim	.0022"	3	3	3-4	3	4	4.0	100	5	12
Second skim	.0008"	2	2	2-3	2	4	4.0	150	3	15
Third skim	.0004"	1	1	5-7	5-7	4	8.0	100	3	17
Fourth skim	.0002"	1	1	3-4	3-4	3	8.0	100	3	18
Fifth skim	.0001"	1	1	2	2	3	8.0	100	1	20

PRINCIPLES OF WIRE-CUT ELECTRICAL DISCHARGE MACHINING (EDM)

Introduction

EDM machining is a thermal process. The material is removed by heating the workpiece to a temperature that the material is vaporized. There is no contact between the wire electrode and the workpiece when machining is taking place. If contact is made, burning will immediately stop. By increasing or decreasing the amount of spark energy applied to the workpiece determines how fast the removal rate of material will be. Increasing or decreasing the amount of spark energy will also affect how coarse the surface finish of the wire-cut part will be. Because of the high temperatures, the wire and chips must be cooled. The dielectric fluid is used for this. It forms a barrier between the wire electrode and the workpiece. Without this fluid the wire would burn up immediately because of the high electrical current that is being produced.

Objectives

Upon successful completion of this lesson, the trainee will acquire the knowledge of:

1. EDM motor drives.
2. Spark on and off time and surface finish.
3. Spark overcut.
4. Importance of dielectric fluid and flushing.
5. Dielectric cooling.

CHAPTER 1

PRINCIPLES OF WIRE-CUT ELECTRICAL DISCHARGE MACHINING (EDM)

Wire-cut EDM is a process for machining electrically conductive materials by sparks in the presence of a dielectric using a traveling wire as the cutting tool. Wire-cut EDM has been described as an electronic band saw. This description is quite good since the shape machined is basically two dimensional and is always machined completely through the workpiece.

Basic components of Wire-Cut EDM machine are shown in Figure 1 and consist of:

A. EDM Power Supply which controls spark energy in the form ON time, OFF time, peak emperes and machining voltage.

B. Electrode wire system which controls the wire traverse rate and the tension on the wire.

C. Dielectric unit which provides the fluid necessary to control the sparking conditions, provide cooling for the workpiece and the electrode wire and remove the EDM chips from the machining area.

D. CNC unit for controlling the shape to be machined.

E. Machine structure which supports the X-Y positioning system.

Position System

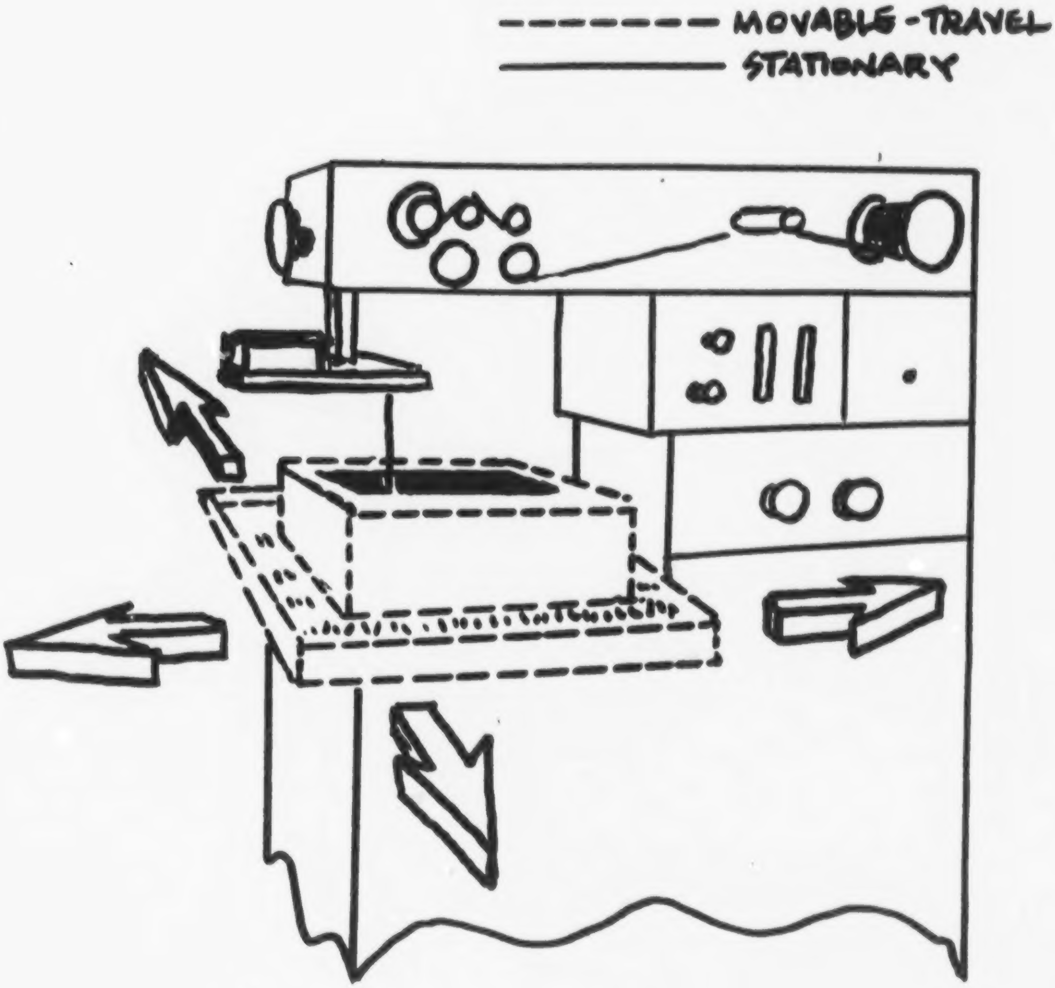
Wire-Cut EDM requires the movement of the workpiece on the electrode in the X and Y axes. When cutting a perpendicular face moves and the electrode wire remains stationary. In some instances the workpiece may travel in the Y-direction and the electrode wire will travel in the X-direction. It is even possible that the electrode would travel in both the X and Y directions with the part being stationary. It makes no difference how the X and Y movements are made so long as there is relative movement between the electrode and the workpiece.

Precision of movement is of prime importance to the X-Y positioning system. Antifriction table ways for X and Y travel assure that the system will respond to the drive motor movement in minute increments.

DRIVE MOTORS

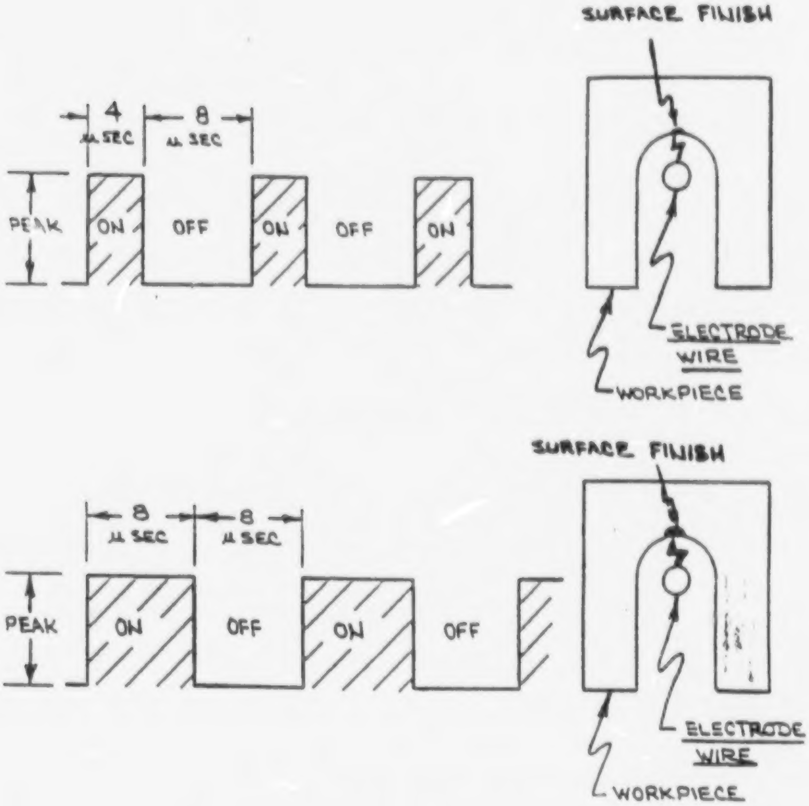
Drive motors must be coupled to the lead screws so that there is no backlash in the system and finally the drive motor must be capable of responding to very small positioning commands. Normal input command to a drive motor may be as small as .00004" (.001 mm). This type of control is necessary to keep the electrode wire in proper position for greatest sparking efficiency as well as to produce the precision in the workpiece shape. Pre-loaded ball bearing lead screws also assure that the drive motor movement is transmitted to the table slides with a minimum of friction.

Movement of the X-Y axes is under the command of the CNC control. The two axis contour is programmed into the CNC control unit.



ON & OFF TIME

ON time is one of the controlling factors in determining spark energy. For the consideration at this point all other factors will be considered constant. Figure 2 illustrates the affect that ON time has on spark energy. The top example shown an ON time of 4 usec and an OFF time of 8 usec. Spark energy in this illustration is based on 4 usec. The lower example establishes a spark energy of 8 usec. The lower example then has twice the spark energy of the upper example. More spark energy produces a higher energy spark which removes more material. It should be noted that higher spark energy also produces a coarser surface finish.


SURFACE FINISH
4 μ SEC
8 μ SEC
PEAK
ON
OFF
ON
OFF
ON
ELECTRODE WIRE
WORKPIECE
SURFACE FINISH
8 μ SEC
8 μ SEC
PEAK
ON
OFF
ON
OFF
ELECTRODE WIRE
WORKPIECE

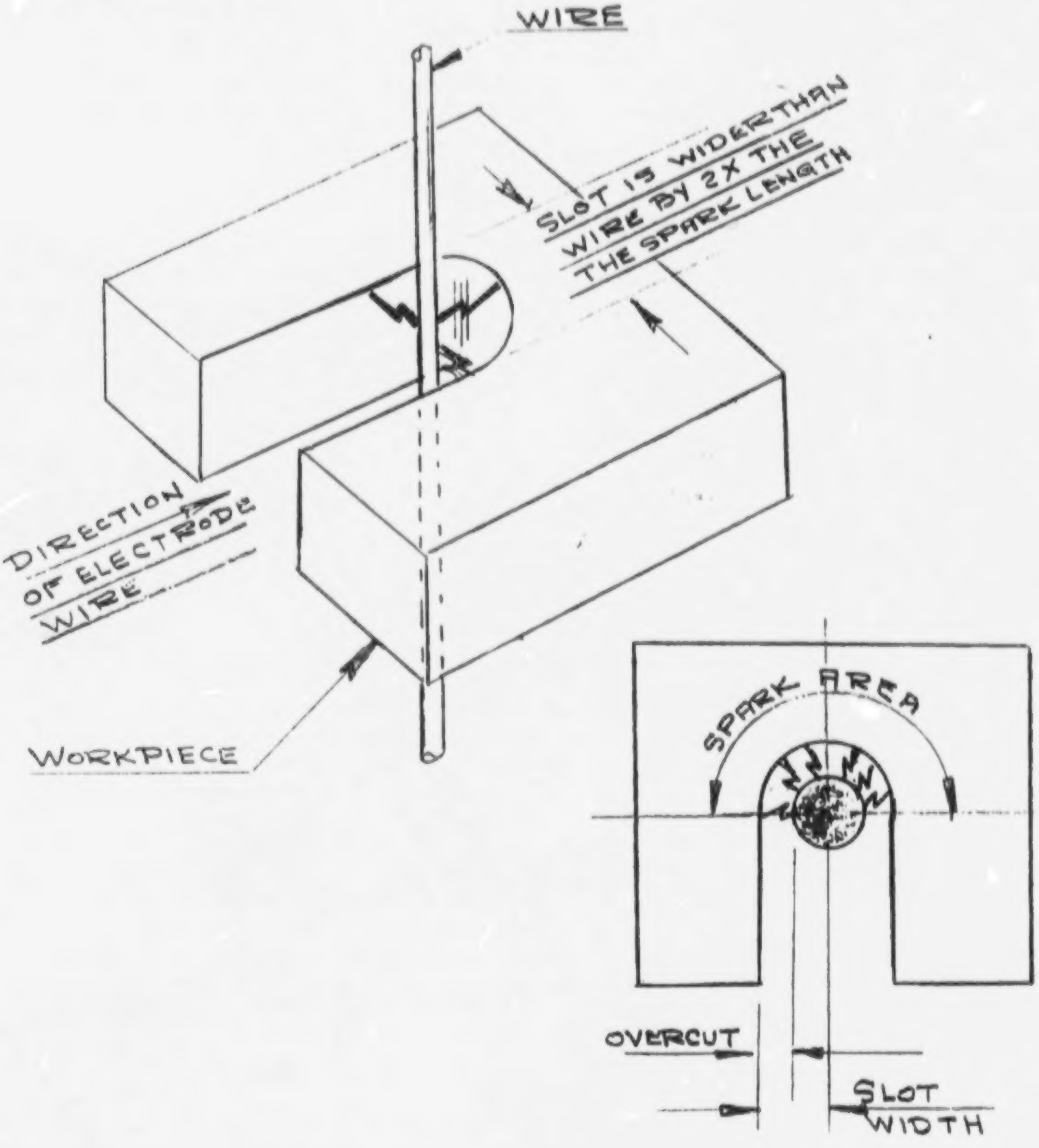
INCREASE ON-TIME = INCREASE IN SPARK ENERGY
(PEAK VALUE MAINTAINED AT SAME VALUE)

FIG. 2. ON-TIME DETERMINES SPARK ENERGY

OVERCUT (SPARK LENGTH)

Wirecut EDM is the same as other machining processes. The opening machined is larger than the cutting tool. In other words, the slot machined by the wire is larger than the wire diameter. The reason for this is that there must be space for the spark between the elcetrode wire and the workpiece material (Figure 3). If the wire contacts the workpiece, a short will occur and burning will stop.

Since overcut is based on spark length, it can be established that the kerf width will be:


WIRE
SLOT IS WIDER THAN WIRE BY 2X THE THE SPARK LENGTH
DIRECTION OF ELECTRODE WIRE
WORKPIECE
SPARK AREA
OVERCUT
SLOT WIDTH

METAL REMOVAL

The rate at which metal is removed by Wire-Cut EDM is dependent on two (2) things:

A. The closeness of one spark to the next spark.

B. The energy in each of the sparks.

Energy in the spark has been shown to increase as the ON time of the spark increases. As spark energy increases, metal removal rate increases (Figure 4). The upper illustration shows a spark energy based on a 4 usec ON time. The lower illustration has a spark ON time of 8 usec. In both illustrations the OFF time is 8 usec. Doubling the ON time (i.e. from 4 usec to 8 usec) also doubles the spark energy. Doubling the spark energy doubles the volume of workpiece material removed per spark. A basic rule can then be established:

INCREASED SPARK ENERGY INCREASES METAL REMOVAL

There is one other factor that must be considered at this time. Notice that the 4 usec spark energy produces a smaller crater than the 8 usec. spark. Since the higher energy spark increases the metal removal, it also results in a coarser surface finish. From this, the basic rule for spark energy and metal removal can be modified to:

INCREASING SPARK ENERGY

- INCREASES METAL REMOVAL
- PRODUCES A COARSER SURFACE FINISH

It is possible to increase metal removal when using Wire-Cut EDM without changing surface finish. This is accomplished by establishing the ON time for an acceptable surface finish. The OFF time is then reduced to increase the number of sparks per second (Figure 5). Each spark has the same spark energy so the same volume of material is removed per spark and the surface finish remains the same. Decreasing the OFF time allows the sparks to happen more often so metal removal rate is increased.

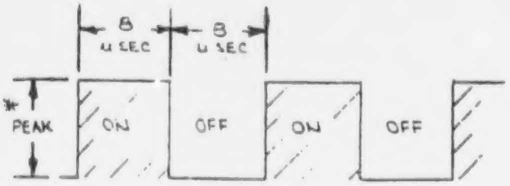
It is possible now to state another rule with regard to Wire-Cut EDM:

MAINTAINING SPARK ENERGY WHILE DECREASING OFF TIME

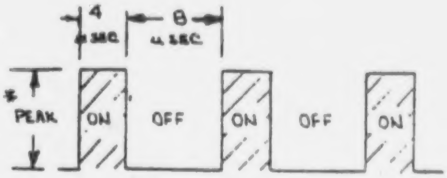
- INCREASES METAL REMOVAL RATE
- DOES NOT CHANGE SURFACE FINISH

In actual operation of the Wire-Cut EDM machine decreasing OFF time while maintaining the spark energy does have limitations. It is possible to decrease the OFF time to the point that excess heating of the electrode wire would take place and wire breakage would result.

On-Time Affect On Surface Finish


8
µ SEC
8
µ SEC
*
PEAK
ON
OFF
ON
OFF

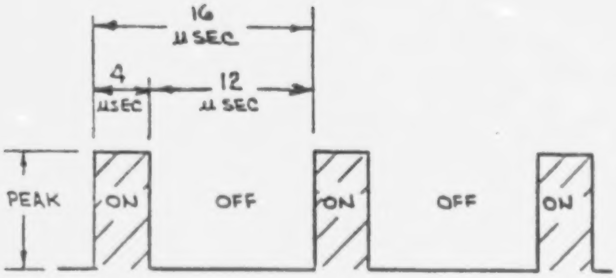
ON TIME TAP = 6
OFF TIME TAP = 2

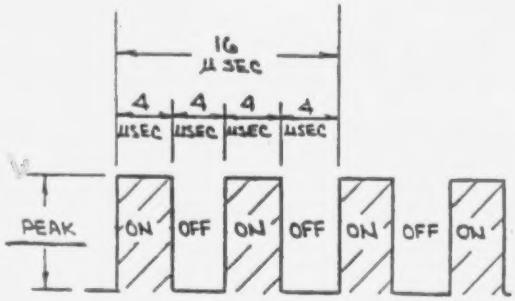

4
µ SEC
8
µ SEC
*
PEAK
ON
OFF
ON
OFF
ON

ON TIME TAP = 3
OFF TIME TAP = 2

Double "ON TIME" = DOUBLE REMOVAL.PER SPARK
= COARSER SURFACE FINISH

Off-Time Decrease & Metal Removal Rate


16
µ SEC
4
µSEC
12
µ SEC
PEAK
ON
OFF
ON
OFF
ON


16
µ SEC
4
µSEC
4
µSEC
4
µSEC
4
µSEC
PEAK
ON
OFF
ON
OFF
ON
OFF
ON

KEEPING SPARK ENERGY THE SAME WHILE

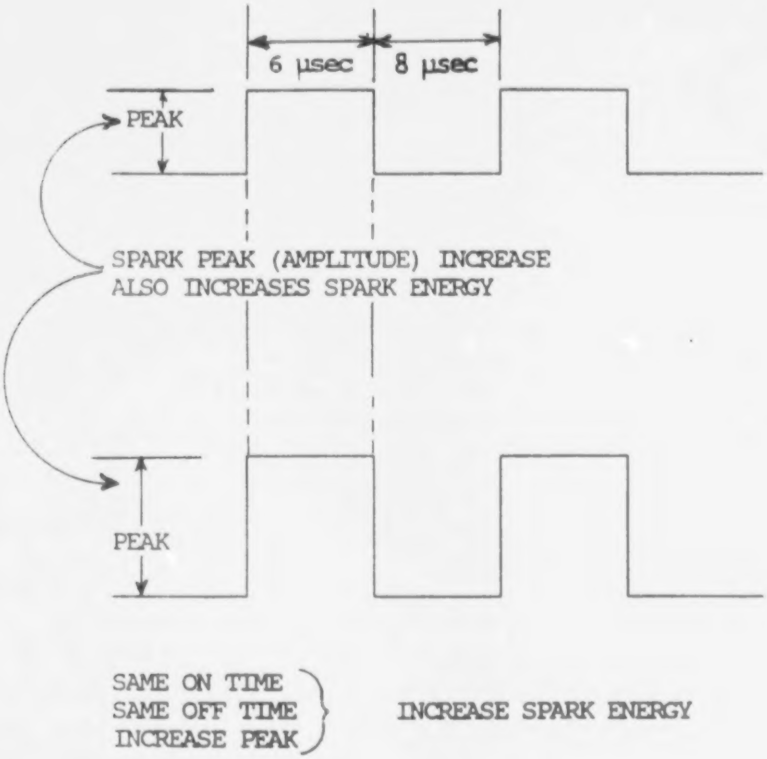
DECREASEING SPARK OFF-TIME

- increases number of sparks per second
- increases metal removal rate
- keeps surface finish the same

(Peak Current)

With the exception of the PEAK control, all other settings will be considered constant. PEAK describes the height of the square wave pulse. To this point, PEAK has been considered constant in the examples shown. In reality, PEAK has been considered constant in the examples show. In reality, PEAK increases spark energy as the amplitude (height) of the square wave is increased.

Figure 6 shows the way in which PEAK increases spark energy. Both illustrations have the same ON and OFF time. The data in the chart shows that PEAK (amperes) increase as the control is set at a higher number. Since ON time and OFF time are not changed in the illustration, it can be seen that the PEAK control changes the amplitude (PEAK) of the spark pulse. A higher or lower spark PEAK brings about a corresponding increase or decrease in SPARK ENERGY.


6 µsec
8 µsec
PEAK
SPARK PEAK (AMPLITUDE) INCREASE
ALSO INCREASES SPARK ENERGY
PEAK
SAME ON TIME
SAME OFF TIME
INCREASE PEAK
INCREASE SPARK ENERGY

SPARK ENERGY INCREASE WITH PULSE PEAK CONTROL

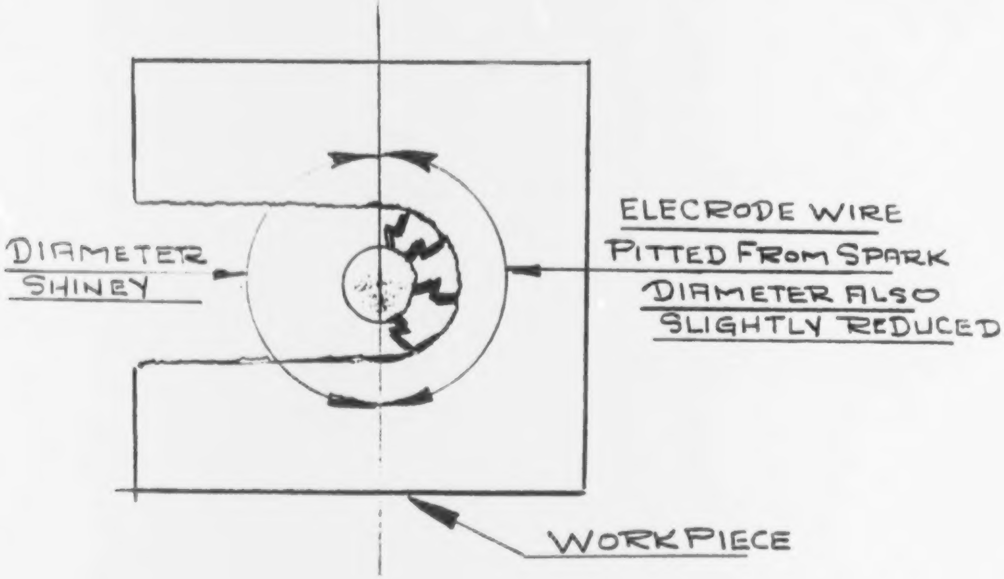
Electrode Wire

The cutting tool for Wire-Cut EDM is the electrode wire. This wire carries the electrical energy in the form of a spark to machine the workpiece. Since the spark does the actual machining without having the wire touch the workpiece, a small diameter brass wire can be used to machine hardened steel or carbide.

Many different materials are used for electrode wire. Some common materials are copper, brass, molybdenum (moly) and tungsten. Brass is probably the most used. Moly and tungsten are used mostly where a small radius is required on an inside corner. These materials have more strength in tension than copper or brass.

Electrode wire is used in a diameter range of from .002" to .016". Of this range of sizes, probably .008" and .010" diameters are most used.

Sparks erode both the electrode wire and the workpiece. As the wire passes through the sparking area, sparking energy is tansferred from the wire to the workpiece. As the spark takes place, it heats a portion of the workpiece surface and material is removed. At the same time, the spark heats the surface of the electrode wire and material is removed from the wire. By comparison, a much smaller amount of material is removed from the wire than the work surface. The electrode wire then takes on a different appearance (Figure 7) as it moves through the work area. The erosion on the wire weakens it to the point where it is not usable as an elctrode wire. For this reason, electrode wire is used once and discarded.

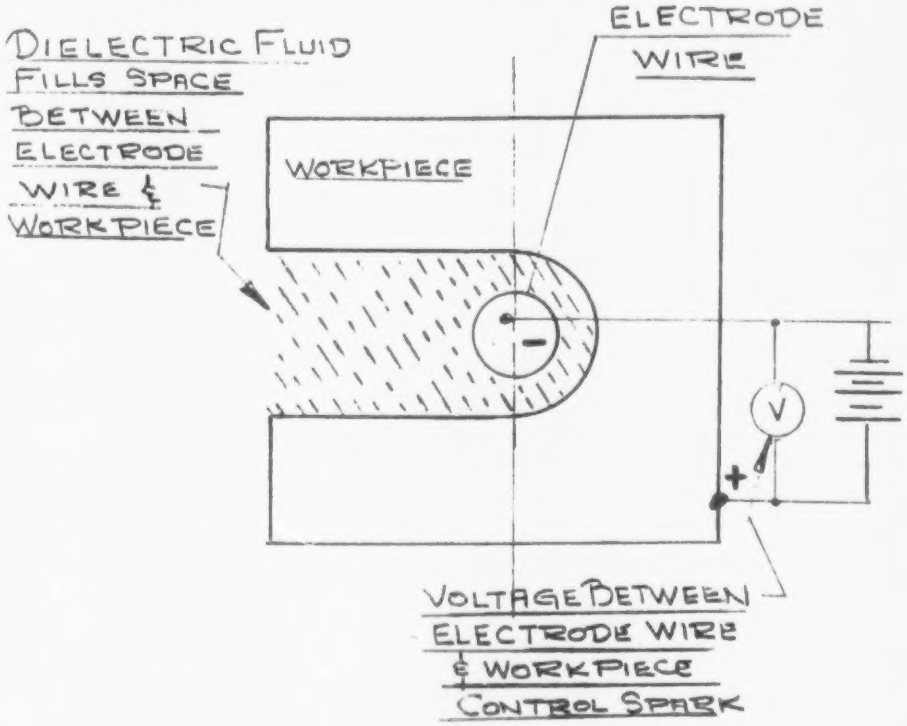


Dielectric

The dielectric fluid used in Wire-Cut machining operations is normally deionized water. This fluid performs three (3) functions. They are:

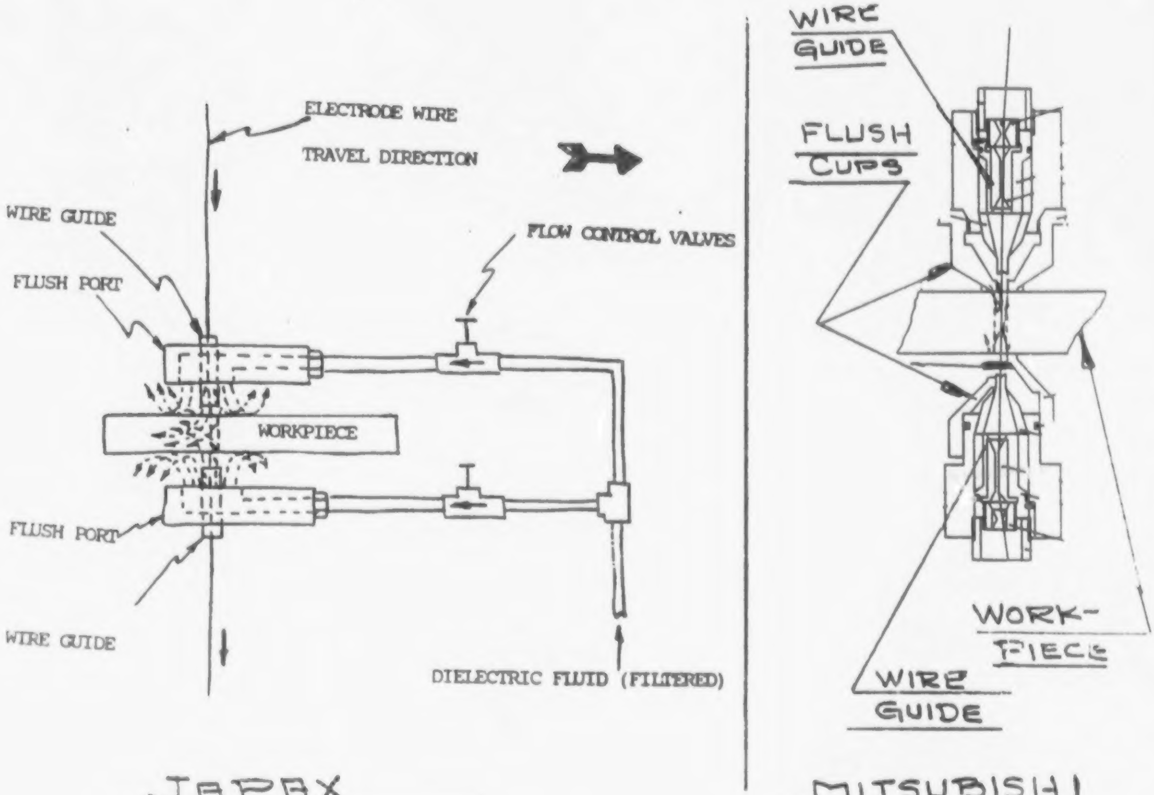
1. The sparking area is surrounded by a material having known dielectric characteristics.
2. The fluid cools the electrode wire and the workpiece.
3. The fluid transports the machined particles away from the sparking area.

Dielectric is an electric term which denotes a non-conductor of electricity. De-ionized water is a non-conductor of electricity until a voltage is applied between the electrode wire and the workpiece which is high enough to cause the water to break down (Figure 8). At that point (called ionization point), the water becomes a conductor of electricity. When the voltage is removed, the flow of electric current ceases and the water returns to its normal condition as a dielectric. This process is repeated for each spark at the rate of many thousands of times per second.


DIELECTRIC FLUID FILLS SPACE BETWEEN ELECTRODE WIRE & WORKPIECE
ELECTRODE WIRE
WORKPIECE
V
+
−
VOLTAGE BETWEEN ELECTRODE WIRE & WORKPIECE CONTROL SPARK

FLUSHING

Since the dielectric material is so important in the sparking cycle, it is also very important that it be very closely controlled during the wire-cut EDM machining cycle. Surrounding the EDM machining area with the fluid is normally accomplished by flowing the water under pressure at the point where the wire enters the cut and also where the wire exits (Figure 9). It is most important that the water completely surround the sparking area so that a known dielectric condition exists.


ELECTRODE WIRE
TRAVEL DIRECTION
WIRE GUIDE
FLUSH PORT
FLOW CONTROL VALVES
WORKPIECE
FLUSH PORT
WIRE GUIDE
DIELECTRIC FLUID (FILTERED)
WIRE GUIDE
FLUSH CUPS
WORK-PIECE
WIRE GUIDE

JAPAX

MITSUBISHI

FIG. 9. SYSTEM FOR SURROUNDING WIRE WITH DIELECTRIC

THERMAL PROCESS

Electrical Discharge Machining is a thermal process. This means that material removal is accomplished by heating the workpiece to the point that the material is vaporized (Figure 10). Heating however, is limited to a very small area of the workpiece surface. Because the energy per spark is very small, the heat of the vaporized material can be removed quickly by the dielectric fluid. When proper fluid flow is used, the workpiece and electrode wire should never feel warmer than the temperature of the dielectric fluid being used.

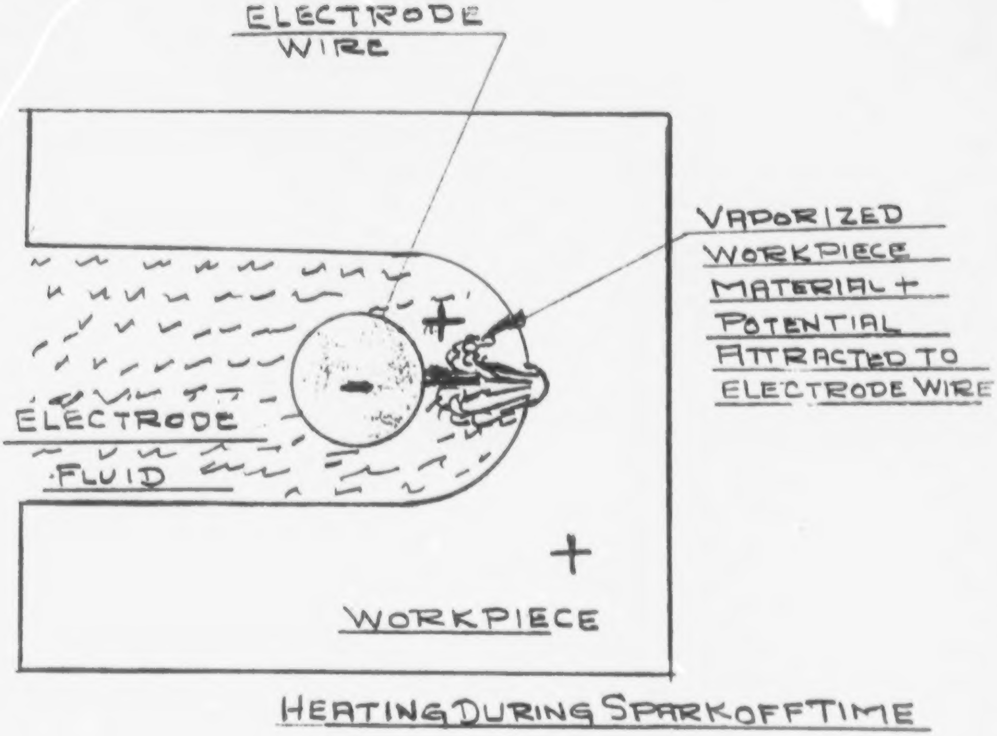

ELECTRODE WIRE
VAPORIZED WORKPIECE MATERIAL + POTENTIAL ATTRACTED TO ELECTRODE WIRE
+
-
ELECTRODE FLUID
+
WORKPIECE
HEATING DURING SPARK OFF TIME

FIG. 10. SPARK ENERGY HEATS & VAPORIZES WORKPIECE MATERIAL

Dielectric Cooling

Cooling of the vaporized material causes the vapor to re-solidify (Figure 11). The vapor then becomes a solid and takes the shape of a very small sphere. The sphere is very small. For most machining, the diameter of the sphere would be less than .0005" (.012 mm). The sphere is actually the EDM "chip".

EDM chips are produced at rates of many thousands per second. As with any machining process, the chips must be removed or inefficient machine operation will result. Chip removal for Wire-Cut EDM is accomplished by causing the dielectric fluid to move through the sparking area (Figure 11). The movement of the fluid transports the chips away from the surface being machined and assures that uncontaminated fluid is always present in the sparking area.

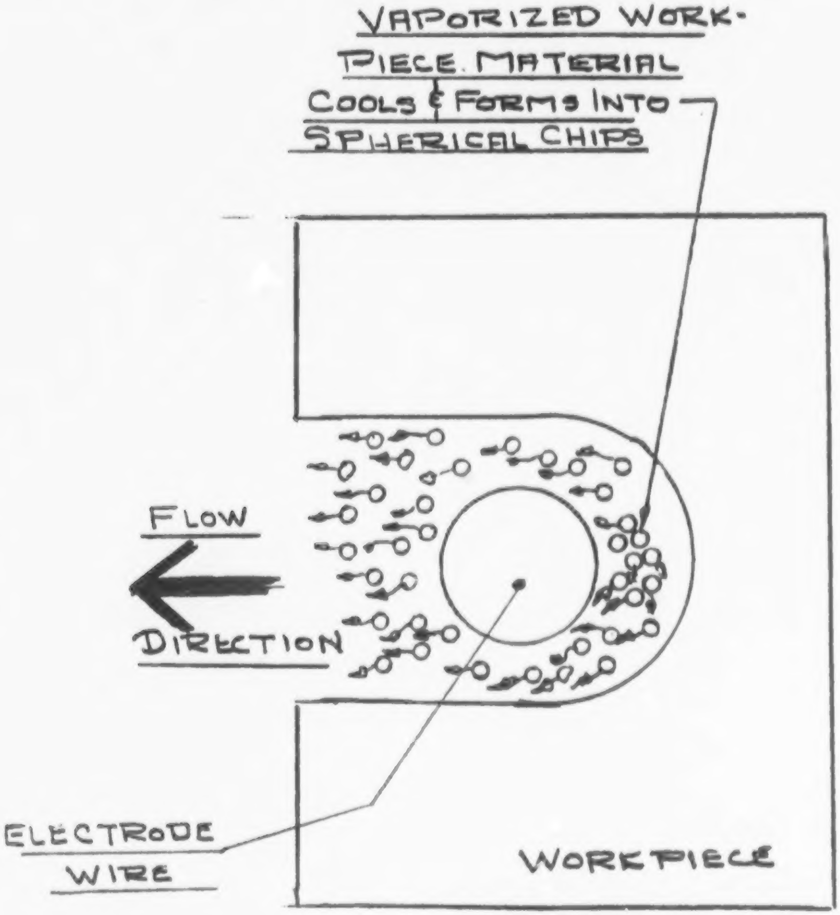

VAPORIZED WORK-
PIECE MATERIAL
COOLS & FORMS INTO
SPHERICAL CHIPS
FLOW
DIRECTION
ELECTRODE
WIRE
WORKPIECE

FIGURE 11
VAPORIZIED WORKPIECE
MATERIAL COOLED & FLUSHED
DIELECTRIC FLUID

SUMMARY
WIRE-CUT EDM PRINCIPLES

1. EDM is a thermal process. Material is removed by heat.

2. Both the electrode wire and workpiece must be materials that conduct an electric current.

3. Machining is accomplished by sparks.

4. EDM sparks contain energy.

5. Spark energy does the machining. There is no contact between the electrode wire and workpiece when machining is taking place.

6. Spark energy is determined by
   (a) SPARK ON TIME
   (b) SPARK PEAK

7. Spark energy determines
   (a) material removed per spark
   (b) surface finish

8. Increasing spark energy
   (a) increases material removed per spark
   (b) produces coarser surface finish

9. Decreasing spark energy
   (a) decreases material removed per spark
   (b) improves surface finish

10. Decreasing SPRAK OFF time
   (a) increases metal removal rate
   (b) does not affect surface finish

11. Increasing SPARK OFF time
   (a) decreases metal removal rate
   (b) does not affect sruface finish

12. Dielectric fluid is used to
   (a) form a dielectric barrier between the electrode wire and the workpiece
   (b) cool the chips
   (c) remove the chips from the work area

Notes:

Unit 20

Introduction

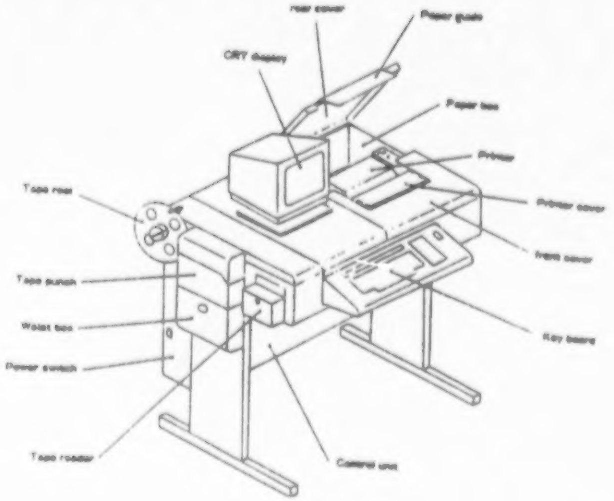
A program will be developed on the Mitsubishi Medi-apt program station and sent to the Mitsubishi wire EDM to burn a part to a very exact size.

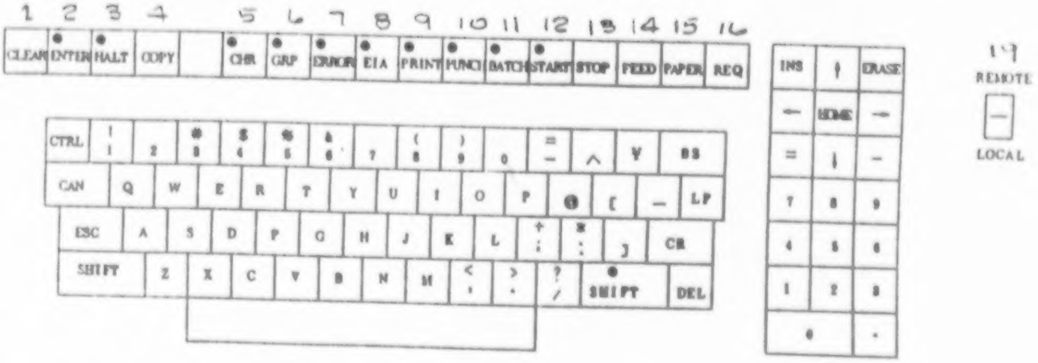
Objectives

Upon successful completion of this lesson, the trainee will be able to:

1. Indentify the various keys on the Medi-apt computer.
2. Use some of these keys to write a CNC program.
3. Use points and lines to write a CNC program.
4. Identify various abbreviations used on the Medi-apt.
5. To use some of the abbreviations when writing a CNC program.
6. To take steps to correct any errors.
7. To plot a part after it has been programmed.
8. To send program to machine.

MEDI-APT TYPE GN


rear cover
Paper guide
CRT display
Paper box
Printer
Tape reel
Printer cover
front cover
Tape punch
Waist box
Key board
Power switch
Tape reader
Control unit


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
CLEAR ENTER HALT COPY CHR GRP ERROR EIA PRINT FUNC1 BATCH START STOP FEED PAPER REQ
CTRL ! 1 2 # 3 $ 4 % 5 & 6 7 (8) 9 0 = – ^ ¥ BS
CAN Q W E R T Y U I O P @ [– LF
ESC A S D F G H J K L + ; * :] CR
SHIFT Z X C V B N M < , > . ? / SHIFT DEL
INS ↑ ERASE
← HOME →
= ↓ –
7 8 9
4 5 6
1 2 3
0 .
17
REMOTE
LOCAL

Key Arrangement

Power **ON OFF** switch. This switch is located at the lower left hand side of the machine. When you turn on the machine the following keys should be on. Light will be lit.

#2 ENTER
#5 CHR
#6 GRP
#19 REMOTE/LOCAL switch should be on local

1. CLEAR (Effective in **REMOTE** and **LOCAL** operation)
The clear key is used to clear information on the CRT display (it will not earse information on the computer). Keep in mind that the the CHR key and the GRP key lights must be on. If you want to only clear one of the two, turn the other light off.

2. ENTER (effective in **REMOTE** and **LOCAL** operation)
This lamp lights when the keyboard permits entry of data. No switch that controls this lamp is provided.
Key-in operation is ignored when this lamp does not light.

3. HALT (Effective only in **LOCAL** operation)
The Halt key is used after you have written the program and want to see a list of the program you have written. Because the program will flash on the CRT very quickly you can push the halt key to stop the list at any time.

4. COPY (Effective only in **LOCAL** operation)
This function key is effective only in **LOCAL** operation, and used to send the character data or grahic data appearing on the CRT screen to the printer.
To use the COPY key the following steps should be taken
    1. Put **LOCAL** remote key on local
    2. Turn on PRINT key (light on)
    3. Turn off CHR key
    4. Push COPY key

5. CHR (Effective in **REMOTE** and **LOCAL** operation)
This key is an alternate key, and used to display character memory contents stored in the graphic typewriter.
Character memeory contents are displayed when CHR lamp lights on.
By depressing the key again, CHR lamp goes out and character data

disappear from the CRT screen.
However, the character memory contents are maintained even after CHR lamp goes out.
For character memory diagnosis, CHR lamp should remain lighting.

6. GRP (Effective in **REMOTE** and **LOCAL** operation)
This key is an alternate switch, and depressed to display graphic memory contents on the CRT screen.
Graphics stored in the graphic memory are displayed while GRP lamp is lighting, and not displayed when GRP lamp does not light on.
However, the graphic memory contents are maintained in the memory even when GRP lamp goes out.
For graphic memory diagnosis, GRP lamp should remain lighting.

7. ERROR (Effective in **REMOTE** and **LOCAL** operation)
This lamp lights and alarm buzzer sound if parity error occurs with data read by the tape reader. Parity error does not affect other functions and operation may be continued.
Therefore tape program having no parity bit can be copied successfully.
By depressing ERROR key, error status can be reset (ERROR lamp goes out).
Parity check is based on even parity when **ISO** code is adapted at the tape rader, while based on odd parity when **EIA** code is adapted at the tape reader.

8. EIA (Nonfunctional on our equipment)

9. PRINT (Effective in **REMOTE** and **LOCAL)**
Print key is used when you require a print out of the progrm, for manual program, copy of medi-apt program, or a screen dump. **Note!** Printer must be turned on before request to print is made.

10. PUNCH (Effective only in **LOCAL** operation)
This key is an alternate switch, and used to turn on and off punch output. The key is effective only in **LOCAL** operation.
Data input from the keyboard or the tape reader when PUNCH lamp lights on

are output to the punch.
PUNCH lamp should light on when character data on the CRT screen is output by depressing COPY key.
Turning on and off the punch is controlled from external computer when **REMOTE** operation is selected, and PUNCH lamp turns on and off according to the control from the computer.

11. BATCH (Effective only in **REMOTE** operation)
This key is depressed when it is desired not to immediately send character data from the key board to external computer in **REMOTE** operation, but to send line by line or to send entire page at once.
Since the cursor and edit keys such as INS and ERASE may be used in **BATCH** operation mode, data can be sent to computer after the edit on the CRT screen.
When only BATCH key is depressed.....
BATCH lamp lights and one-line batch mode occurs.
Since the data cannot be sent unless START or CR key is depressed, it is possible to check the data on the CRT screen before sending them to computer.
When START or CR key is depressed, all data on the line, where the cursor exists, are sequentialy sent from the character at the left end of the line to computer.
At the end of data transmission, the one-line batch mode is reset and then data are sent character by character.

When BATCH key is depressed while holding down CTRL key.....
BATCH lamp flickers and one-page batch mode occurs.
Data transmission to computer starts when START key is depressed, and data of 24 lines are sent.
If no data exists in any line, only **CR** code is sent to computer for that line.
When all data on one page have been sent, the one-page batch mode is reset and then data are sent character by character.
During one-page batch mode, START lamp lights on and data sent from the computer to the graphic typewriter are ignored.

12. **START** (Effective in **REMOTE** and **LOCAL** operation)
When **BATCH** lamp lights on in **REMOTE** operation.....
When **START** key is depressed during one-page mode (**BATCH** lamp lights on), all data on one page (24 lines) are sent to computer and **START** lamp lights.
When the data transmission is completed, the batch mode is reset.

When only **START** key is depressed.....
the program on the paper tape loaded on the tape reader is read, and displayed on the CRT screen, as well as printed or punched depending on whether **PRINT** lamp or **PUNCH** lamp lights.

When **START** key is depressed while holding down **STOP** key in **LOCAL** operation
Data are read character by character by the tape reader, and displayed on the CRT screen, as well as printed or punched depending on whether **PRINT** lamp or **PUNCH** lamp lights.

13. **STOP** (Effective only in **LOCAL** operation)
This key is used to stop the tape reader, and also to stop copying of the CRT screen, started by depressing **COPY** key.
Everytime **START** key is depressed while **STOP** key is held down, one character is read by the tape reader, and displayed on the CRT screen.

14. **FEED** (Effective only in **LOCAL** operation)
While this key is held down, the punch punches only feed holes even when EIA mode is selected.

15. **PAPER** (Effective only in **LOCAL** operation)
While this key is held down, the printer shifts lines.
The function is invalid for **REMOTE** operation.

16. **REG** (Effective only in **REMOTE** operation)
This key is depressed to send a request signal to the MEDIAPT.
When the key is depressed, "$" (MEDIAPT G-1) or "·" (MEDIAPT G-2 or G-3) appears on the CRT screen, enabling input of command signal.

19. REMOTE/LOCAL select switch

This switch is used to connect the graphic typewriter to, and disconnect from computer.

When the switch is set at REMOTE position, the graphic typewriter is connected to computer and data transmission becomes possible.

With the switch set a LOCAL position, data processing is carried out in the graphic typewriter alone. We will use only on LOCAL when we want a screen dump.

Codes And Sequences For Programming
Mitsubishi Wire EDM

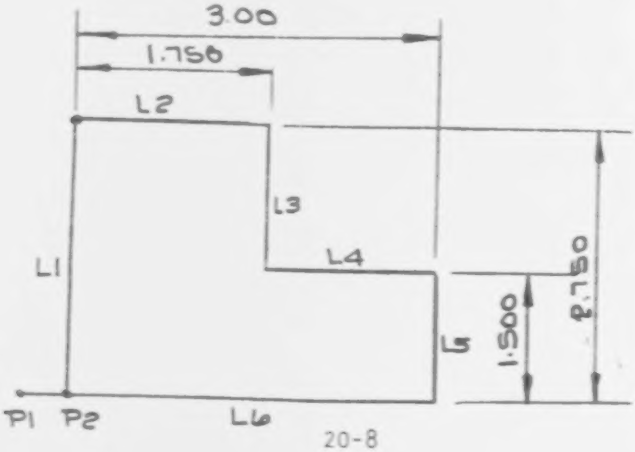
Turn on Medi-apt (Left side lower left hand corner) and type in information as follows (carriage return is pushed to end each line)

Dollar Sign Will Appear

```
  $ New  (clears all information from Medi-apt memory)
  $ INC  [mode INC (inch)  MIL (metric)]
  $ KEY  [input KEY (keyboard)  TAP (input from paper tape)]
```

Sequence Number Will Appear

```
0010  P1:X-.200/Y0  (starting position for wire)
0020  P2:X0/Y0
0030  L1=X0
0040  L2=Y2.75
0050  L3=X1.75
0060  L4=Y1.50
0070  L5=X3.00
0080  L6=Y0
0090  MINR/.015 (min radius any corner, can be any size, see below*)
0100  Set/P1,L
0110  ;;;;F500M90;
0120  P2
0130  L1
0140  L2
0150  L3
0160  R  (*put R between each line where above specified radius is required)
0170  L4
0180  L5
0190  L6
0200  P2
0210  STOP  (tell program to stop)
0220  ;;;; G40F5000M91;
0230  P1  (will tell to go back to start point)
0240  END
0250  MEND
      MTN (MTN will check program for error)
```



The Following Abbreviations Are Used To Give Various Commands to the Medi-apt

Change or Command Required By Operator	Abbreviation Used	
To change or replace a line	$REP,0100	line number you wish to replace or change
To delete or eliminate a line	$DEL,0100	line number you wish to replace or change
To insert or add information	$INS-0101	number 1, on left must be used to insert information. This cannot be "0"
To list information as you have typed it into computer	$LIS	
To make paper tape of what you typed or programmed (this tape will not work to run program on the machine)	$PUN	
To plot the program you have written on the medi-apt screen	PLT,2,1,3,	scale on size of plot distance from left side of screen to start of plot distance from top of screen to start of plot
To put title on paper tape	$TTL	- computer will ask for title after you push carriage return
	TITLE	- type in title you require

To transfer information from paper tape you have previously made to the computer	$NEW - carriage return $INC - carriage return $TAP - carriage return
To make CNC paper tape to be used to reun program on machine (this cannot be used to put program back on the computer)	MTN,TP
To get copy of plot on paper (printer will point whatever is on monitor screen)	1. push Local, mode key (far right on medi-apt 2. turn off CHR key (this will turn off list on commands or moves on the screen) 3. turn on Print key 4. push Copy key
To transfer NC Program to machine	MTN,MM(L-100) - give your number (it must be preceded by an "L-")

APT WORDS

P...POINT
L...LINE
C...CIRCLE
R...RIGHT

L...LEFT
U...UP
D...DOWN
CW..CLOCKWISE

CC...COUNTERCLOCKWISE
D ...DISTANCE
N ...NORMAL (PERP.)
P ...PARALLEL

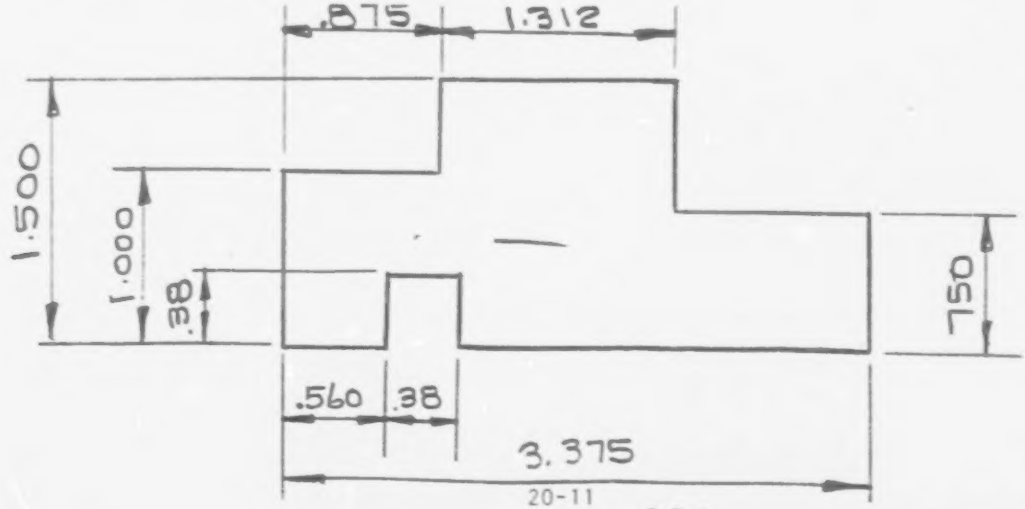
A...ANGLE
R...RADIUS
I...INSIDE
O...OUTSIDE

Writing a CNC Program Using the Medi-apt Computer

Write a program using the Medi-apt computer for the punch and die shown below:

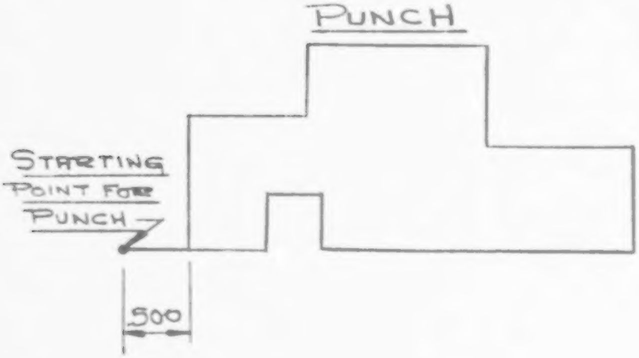
Write your program on the proceeding page before entering it into the computer.

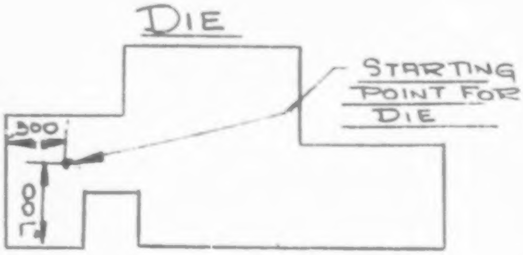
1. The first step is to enter in:
```
$NEW
$INC
$KEY
```
2. Enter your program using points and lines.
   Note! They do not need to be listed in any particular order this will be set below.
3. Enter in:
```
MINR/008
SET/P1,L
;;;;F500M90;
```
4. List move from points to lines or lines to lines. They must be in order for the wire to move.
5. Enter in:
```
STOP
;;;;G40F5000M91;
END
MEND
MIN
```
6. When you enter MIN it will tell you if you have any errors. If you do have any errors see page   to make any corrections.
   Note! You may need to see your instructor for help.
7. Plot part. See page   .
8. Send program to machine. See page



Writing a CNC Program Using the Medi-apt Computer

Write a program for the punch and die shown below. Remember that almost the same program can be used for both punch and die, only the starting points and ending point will change.


PUNCH
STARTING POINT FOR PUNCH
500


DIE
STARTING POINT FOR DIE
500
800

Notes:

Unit 21

Introduction

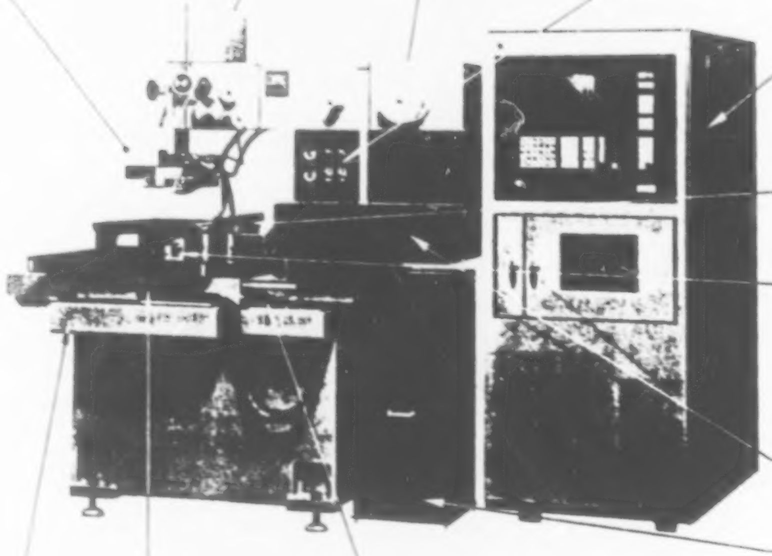
An explanation will be given on all the CRT settings and display unit configuration of the 90G Mitsubishi wire EDM machine.

Ojectives

Upon successful completion of this lesson, the trainee will acquire the knowledge of:

1. The control unit components of the machine.
2. The CRT screen and it's function.
3. Various uses of the echo switches.
4. Various data keys.
5. Various control unit components.

DWC90



Head

A guide clearance suitable for the thickness of the workpiece is obtainable by moving the upper wire guide upward or downward.

Upper Wire Guide

Guides the wire and feeds power to the wire. The perpendicularity of the wire to a workpiece is adjusted by inching this guide in the U and V directions.

Guides the wire and feeds power to the wire. The perpendicularity of the wire to a workpiece is adjusted by inching this guide in the U and V directions.

Column

Provided with the wire tension adjusting mechanism.

Dielectric Fluid Operating Section

Provided with valves and other components to inject dielectric fluid over the machining area. Flow volume is indicated on the flow meter provided on the front face of the column.

Control Unit

Contains the machine power supply unit and control unit operation board.

Table

A workpiece is mounted on this table.

Lower Wire Guide

Guides the wire and feeds power to the wire. This guide is provided with a nozzle to inject dielectric fluid upward in parallel to the wire.

Used-Wire Collecting System

Takes up the wire.

Used-Wire Collecting Box

Collects consumed wire.

Operation Box

Cross Table

Moves a workpiece in the X and Y directions as specified in an NC tape.

Checker

Draws the figure specified in an NC tape, using a ball-point pen, for checking before machining. Because this checker draws the table movement, turn the check form by 180° to check the wire movement.

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CRT Setting and Display Unit Configuration

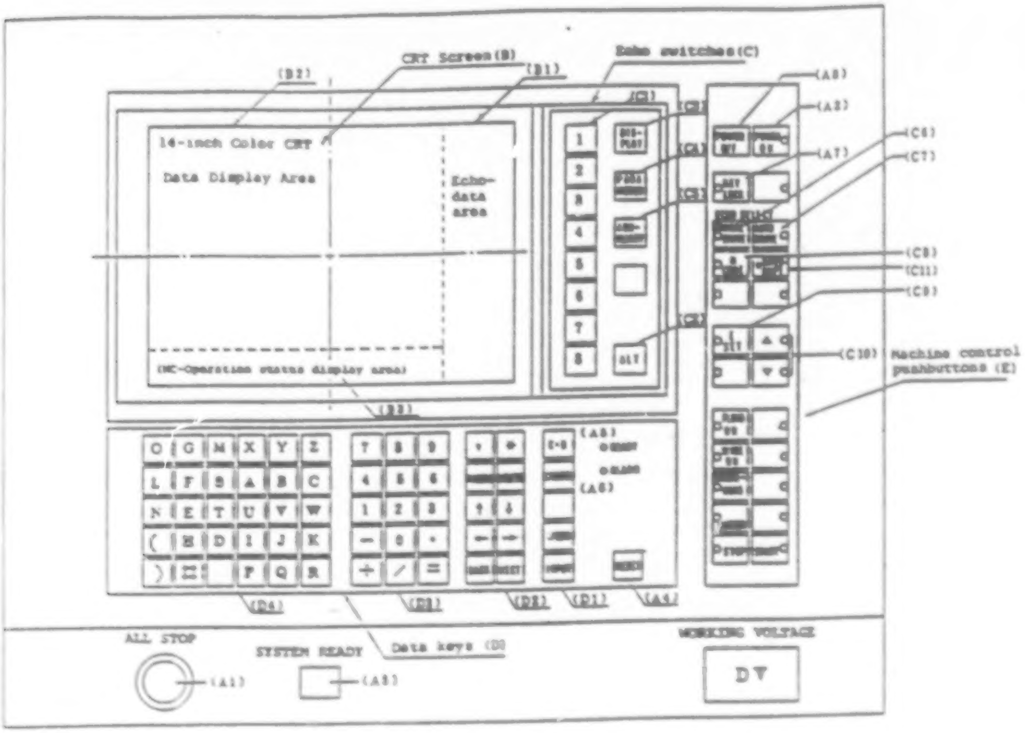
CRT Screen (B)
Echo switches (C)
(B2)
(B1)
(B3)
14-inch Color CRT
Data Display Area
Echo-data area
(NC-Operation status display area)
(C1)
(C2)
(C4)
(C3)
(C5)
DIS-PLAY
ALT
(A3)
(A2)
(A7)
(C6)
(C7)
(C8)
(C11)
(C9)
(C10)
Machine control pushbuttons (E)
(A5)
(A6)
(A4)
(D4)
(D3)
(D2)
(D1)
Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A5)
WORKING VOLTAGE
DV

Figure 1 shows the CRT setting display unit (also called the NC operation board) configuration.

(A) Control unit components

(A1): ALL STOP pushbutton turns off all power except to the W6.

(A2): POWER ON pushbutton turns on power to the W6.

(A3): POWER OFF pushbutton turns off power to the W6.

(A4): RESET pushbutton resets the W6. RESET is used to release NC alarms when power is restored.

(A5): SYSTEM READY pushbutton readies the W6 for operation.

(A6): NC ALARM indicator lights when an alarm occurs in the W6.

(A7): KEY LOCK pushbutton locks all switches on the CRT unit except for ALL STOP (A1), POWER OFF (A3), KEY LOCK (A7), and SYSTEM READY (A5).

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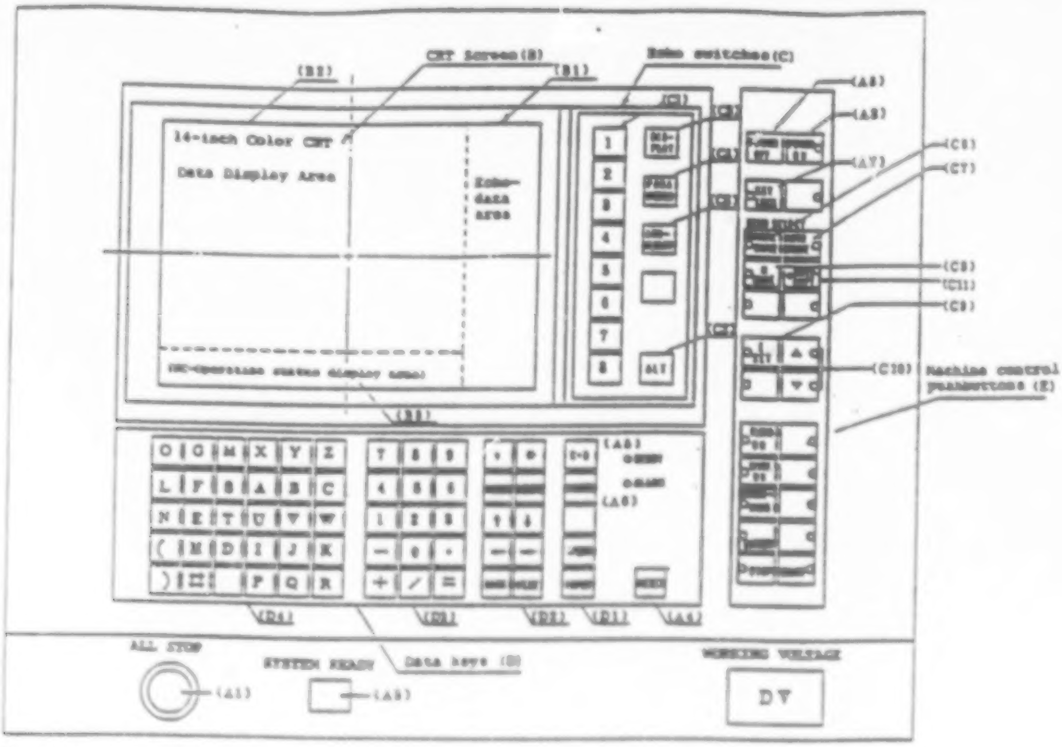

(B2)
CRT Screen(B)
(B1)
Echo switches(C)
(C1)
14-inch Color CRT
Data Display Area
Echo-data area
(B3)
1
2
3
4
5
6
7
8
ALT
(C2)
(C3)
(C4)
(C5)
(A8)
(A3)
(A7)
(C6)
(C7)
(C8)
(C11)
(C9)
(C10)
Machine control pushbuttons (E)
(A6)
(A4)
Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A5)
WORKING VOLTAGE
DV

(B) CRT screen

(B1): Echo-data area, displays up to 16 menu items for activating various functions of W6.

(B2): Data area, used to indicate the current position, monitor the machining operation, and edit programs.

(B3): Status area, indicates the current operating status of the W6.

(C) Echo switches

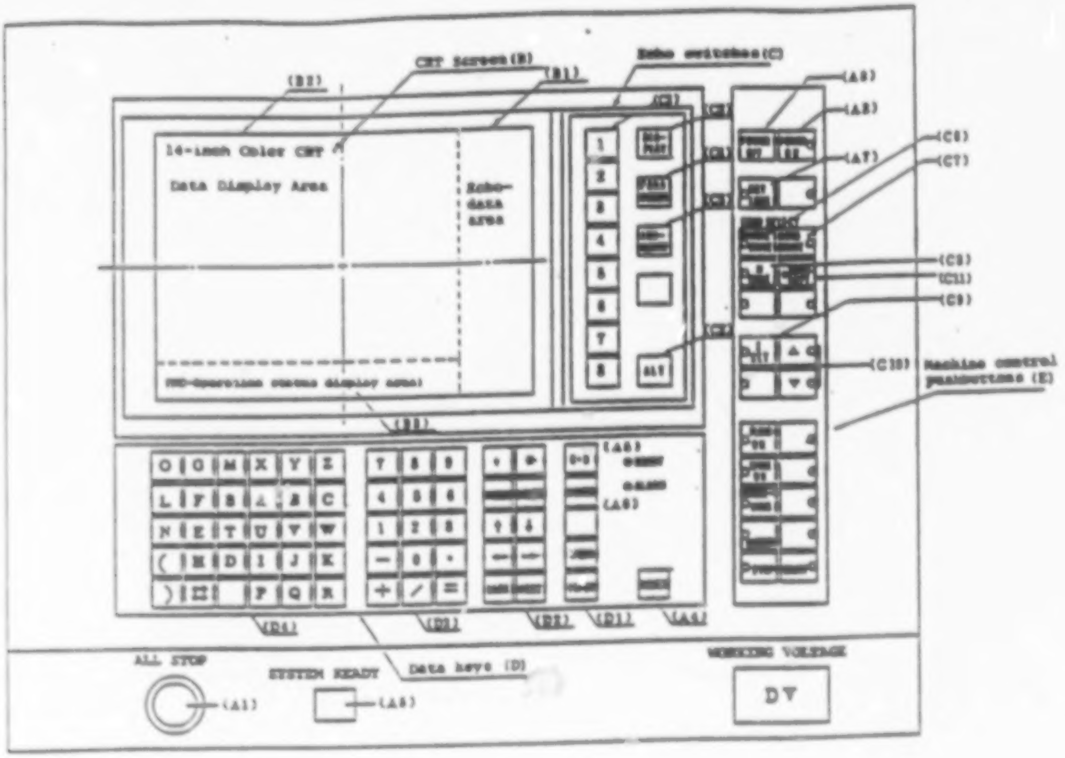
(C1): Menu selection keys (C1), numbered 1 through 8, are used to select menu items in the echo-data area (B1).

(C2): Up to 16 menu items, listed vertically in 8 pairs, appear in the echo-data area (B1). The ALT key (C2) designates either the upper or lower part of the menu pair selected by numeric key (C1).

(C3): DISPLAY key displays the menu in the echo-data area (B1).

(C4): PARAMETER key displays the parameter menu related to NC programs in the echo-data area (B1).

(C5): AUXILIARY key displays the parameter menu for establishing the machining operation status in the echo-data area (B1).


CRT Screen(B)
Echo switches(C)
(B2)
(B1)
14-inch Color CRT
Data Display Area
Echo-data area
(B3)
Machine control pushbuttons (E)
(C10)
(C6)
(C7)
(C8)
(C11)
(C9)
(A7)
(A8)
(A9)
(A4)
(D1)
(D2)
(D3)
(D4)
Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A5)
WORKING VOLTAGE
DV

(C6): MANUAL DRIVE key displays the manual operation menu in the echo-data area (B1).

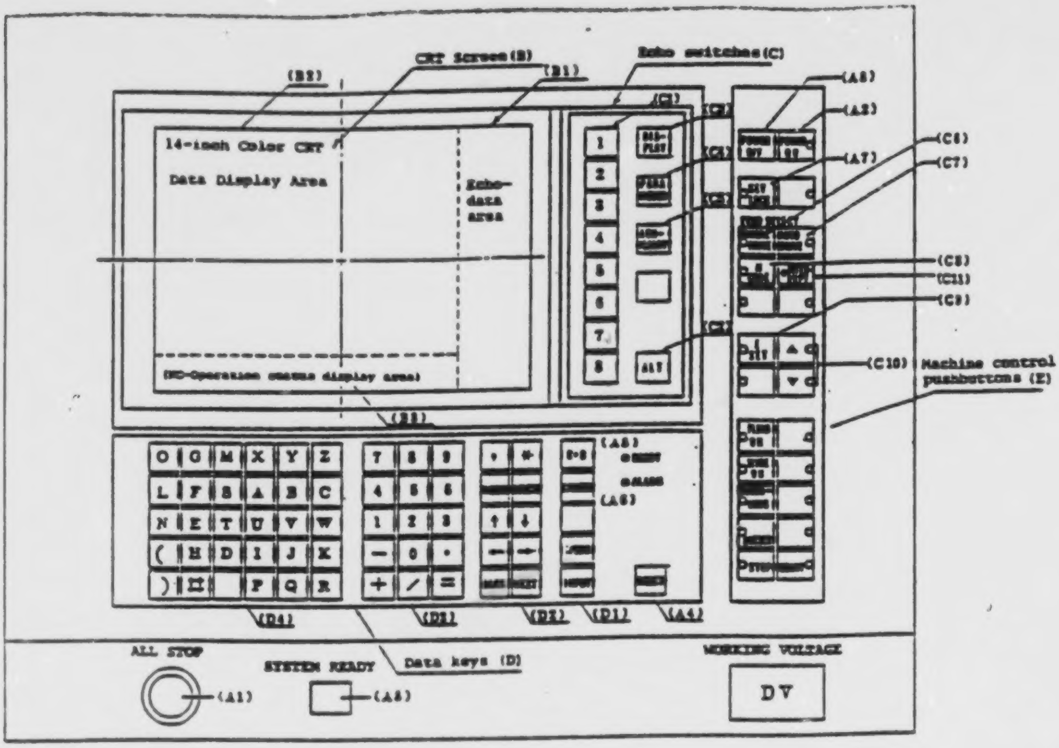
(C7): AUTO DRIVE key displays the automatic operation menu in the echo-data area (B1).

(C8): M CODE key displays the M-function menu in the echo-data area (B1).

(C9): E SET key displays the electric machining condition menu in the echo-data area (B1).

(C10): ▲, ▼ keys are used to change the electric machining condition designated by the E SET key (C9).

(C11): INTERRUPT switch is used to select the interrupt mode, allowing the operator to check and change data during machining.


CRT Screen (B)
(B2)
(B1)
Echo switches (C)
(C1)
(A8)
(A2)
(C6)
(A7)
(C7)
(C8)
(C11)
(C9)
(C10)
Machine control pushbuttons (E)
14-inch Color CRT
Data Display Area
Echo-data area
(NC-Operation status display area)
(B3)
1
2
3
4
5
6
7
8
ALT
(A5)
(A6)
O G M X Y Z
L F S A B C
N E T U V W
(H D I J K
) P Q R
7 8 9
4 5 6
1 2 3
— 0 .
+ / =
(D4)
(D3)
(D2)
(D1)
(A4)
Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A3)
WORKING VOLTAGE
DV

(D) Data keys

(D1): Key group is used to enter and edit data.

(D2): Key group is used to control the screen and cursor.

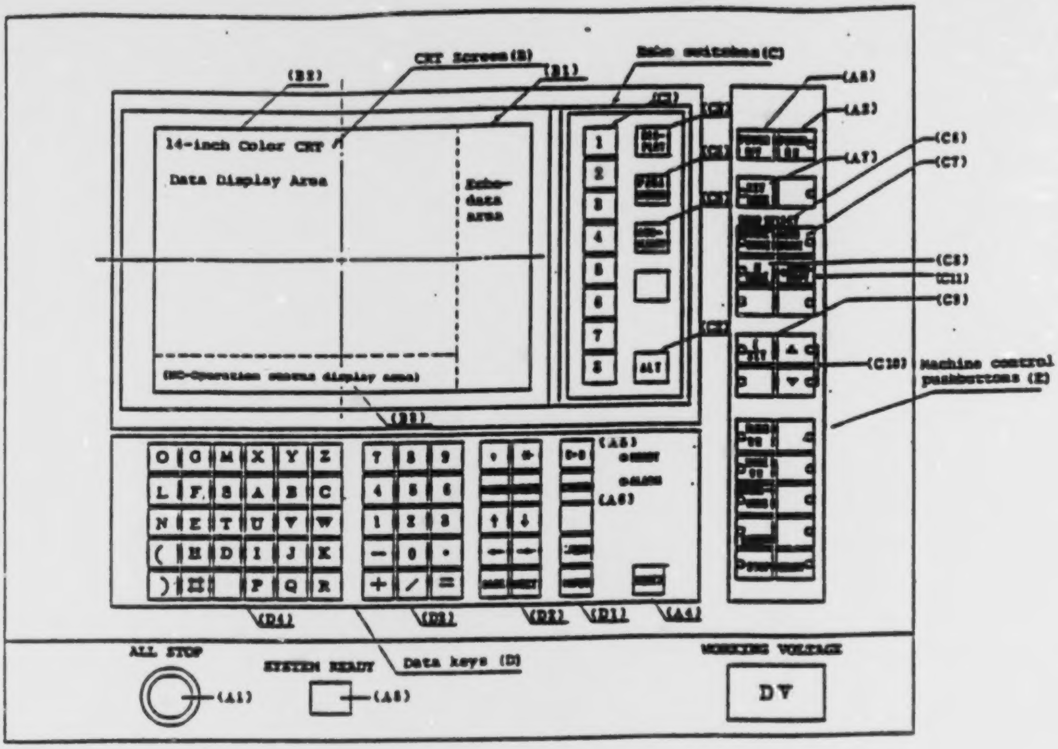
(D3): Key group is used to enter numeric and special characters on the screen.

(D4): Key group is used to enter alphabetic and special characters on the screen.

(E) Machine control pushbuttons

Used for direct machine control.

BEST COPY AVAILABLE


CRT Screen (B)
(B2)
(B1)
Echo switches (C)
(C1)
14-inch Color CRT
Data Display Area
Echo-
data
area
(NC-Operation status display area)
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Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A5)
WORKING VOLTAGE
DV

Keys and indicators

Figure -1 shows the data keys, operation pushbuttons, and indicators on the CRT setting and display unit. Their functions and operation are described below.

(A) Control unit components

ALL STOP (A1) pushbutton locks all operations of the machining unit and allows the W6 to operate.

POWER ○ ON	POWER ON pushbutton (A2) turns on power to the W6 and machining unit.
POWER OFF	POWER OFF pushbutton (A3) turns off power to the W6 and the machining unit.
RESET	RESET pushbutton (A4) resets the control unit. When the pushbutton is pressed during operation, the command value register and the buffer register in the control unit are cleared. The contents in the next block and the remaining distance for each axis are also cleared. This key is also used to cancel program error and NC alarms.

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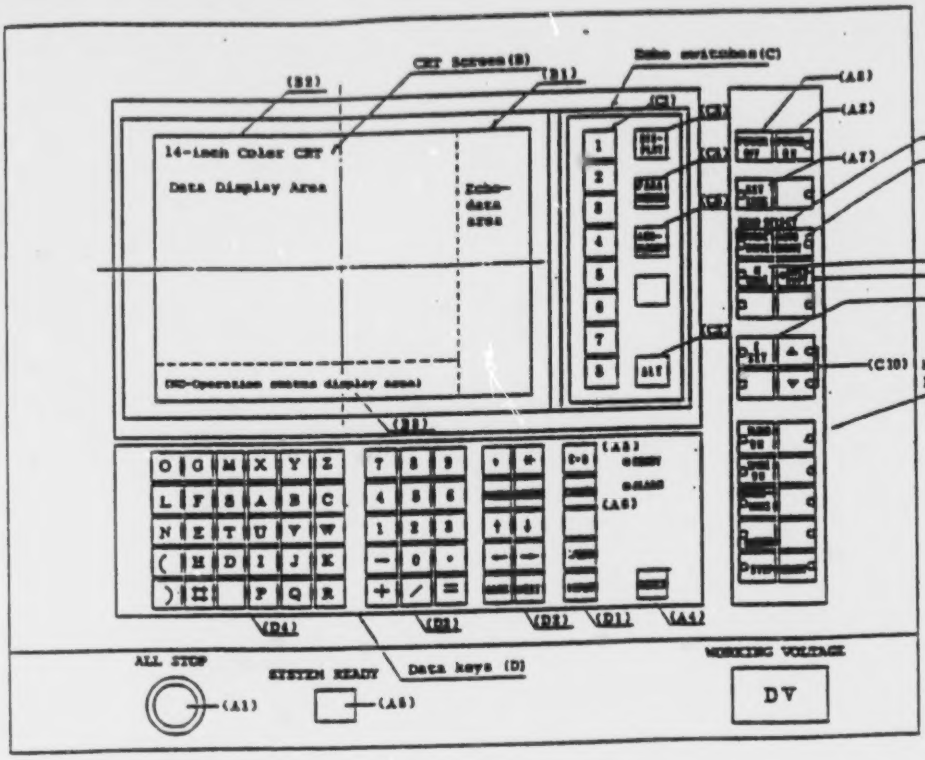
CRT Screen (B)
Echo switches (C)
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Machine control pushbuttons (E)
14-inch Color CRT
Data Display Area
Echo-data area
(NC-Operation status display area)
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(D4)
(D3)
(D2)
(D1)
Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A5)
WORKING VOLTAGE
DV

SYSTEM READY pushbutton (A5)

When the POWER ON (A2) and SYSTEM READY (A5) pushbuttons are pressed, the lamps in both pushbuttons light and the W6 enters the operational mode.

If the control unit enters any of the following abnormal states, the SYSTEM READY lamp turns off:

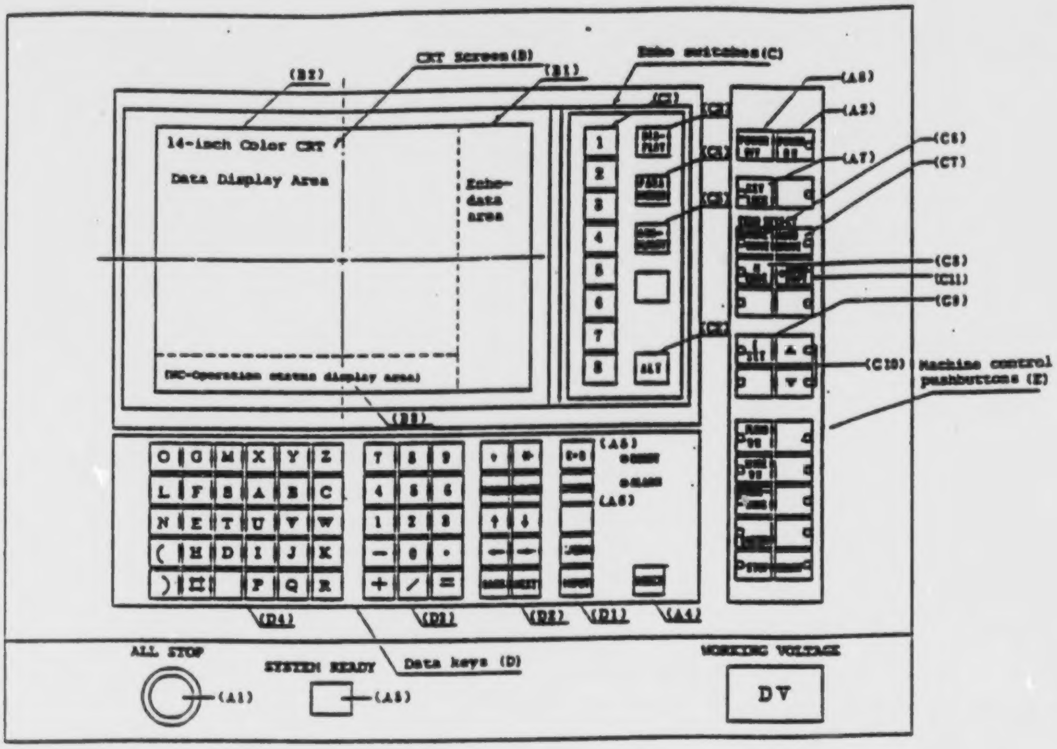
a. Emergency stop occurs

(When the ALL STOP pushbutton (A1) is pressed, the SYSTEM READY lamp turns off, the machine is locked, and the W6 stops.)

b. A large error occurs (machine lags the command value by more than the allowable limit).

c. The transistor amplifier's thermal relay is tripped or the circuit breaker opens.

When a, b, or c occurs, the NC ALARM (A6) indicator lights. Check the error message by selecting sub-menu (1), ALARM, from the main menu (5) ALARM/DIAG in the display mode. Remove the cause and press SYSTEM READY pushbutton (A5) to light lamp; the W6 is ready for operation.


CRT Screen (B)
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(B1)
Echo switches (C)
(C1)
(C2)
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(C4)
(A8)
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(C9)
(C10)
Machine control pushbuttons (E)
14-inch Color CRT
Data Display Area
Echo-data area
(NC-Operation status display area)
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(D3)
(D2)
(D1)
(A4)
Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A3)
WORKING VOLTAGE
DV

d. The DC power source exceeds normal operating limits.

e. A memory parity error occurs.

● NC ALARM (A6) indicator

The indicator lights if the W6 detects a problem. Examples are:

a. Operation alarm

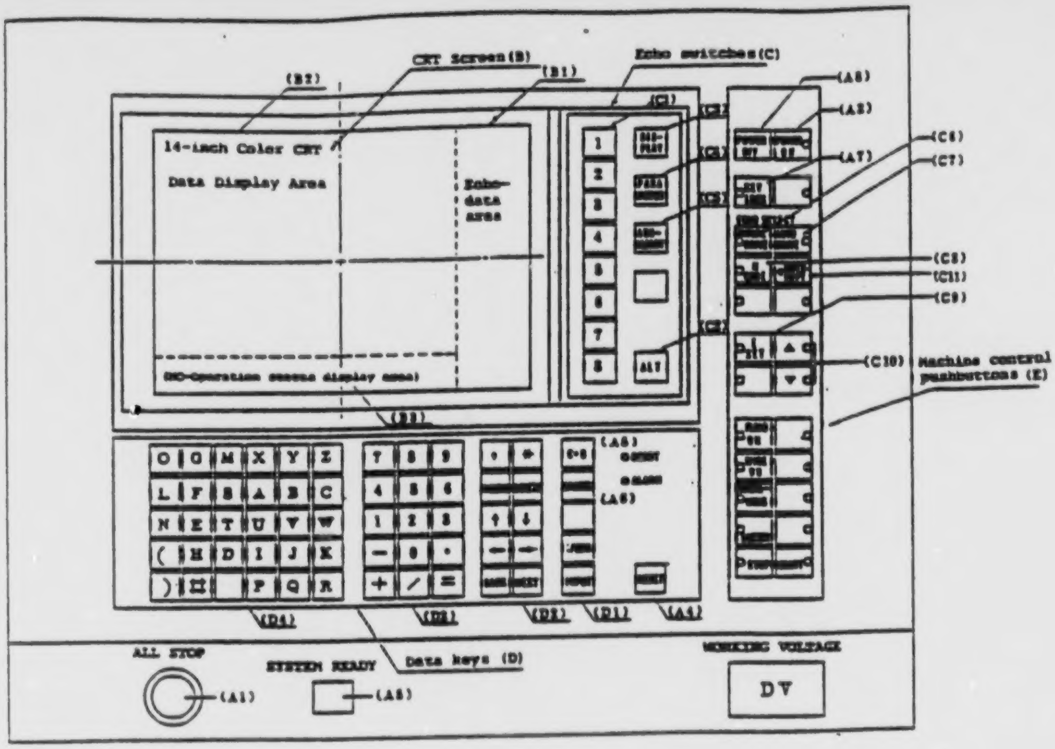
Alarm for an error in the mechanical operation. When the operation is corrected, the NC ALARM indicator turns off.

b. Stroke end alarm

The NC ALARM indicator lights when the control axis reaches the stroke end dog, the stored soft limit area, or the soft limit area.

c. Servo alarm

The NC ALARM indicator lights when a large error occurs; the drive amplifier thermal relay is tripped, the circuit breaker opens; or signals from the position detector disappear.


CRT Screen(B)
Echo switches(C)
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Machine control pushbuttons (E)
14-inch Color CRT
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(D3)
(D2)
(D1)
(A4)
Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A3)
WORKING VOLTAGE
DV

d. Horizontal parity

The NC ALARM indicator lights when a horizontal parity error is detected in the machining tape (odd number if data is in EIA code or even number if in ISO code), or no hole is detected in the significant information block when in EIA code.

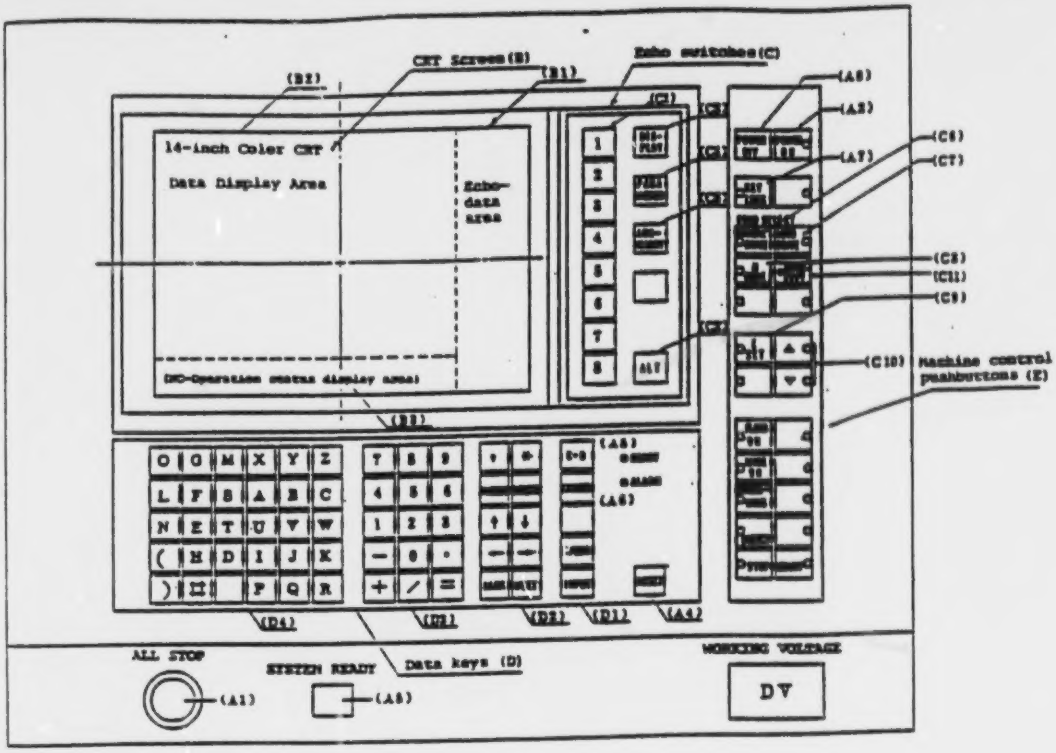
e. Vertical parity

The NC ALARM indicator lights if a vertical parity check is selected in parameter (C4) mode, using the CRT setting and display unit, and the number of significant information block characters in one block is odd.

f. Program error

The NC ALARM indicator lights if the machining program includes an error.

When events a to f occur, the NC ALARM (A6) indicator lights. Check the error message by selecting sub-menu (1), ALARM, from the main menu (5) ALARM/DIAG in the display mode. Remove the cause and press the RESET pushbutton; the W6 is then ready to resume operation.


CRT Screen (B)
Echo switches (C)
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(C1)
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Machine control pushbuttons (E)
14-inch Color CRT
Data Display Area
Echo-data area
(NC-Operation status display area)
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ALT
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(D1)
(A4)
ALL STOP
(A1)
SYSTEM READY
(A5)
Data keys (D)
WORKING VOLTAGE
DV

KEY LOCK

KEY LOCK pushbutton (A7)

When the KEY LOCK pushbutton (A7) is pressed, the red lamp in the pushbutton lights, and all keys are locked and deactivated except for ALL STOP (A1), POWER OFF (A3), KEY LOCK (A7), and SYSTEM READY (A5).

(C) Echo keys

There are 12 echo keys that display corresponding menus in the echo-data area (B1): DISPLAY (C3), PARAMETER (C4), AUXILIARY (C5), MANUAL DRIVE (C6), AUTO DRIVE (C7), M CODE (C8), and E SET (C9). The echo-data key group (C1), consisting of eight numeric keys, selects a pair of menu items; ALT (C2) selects eitehr the upper or lower menu item; and the ▲ , ▼ (C10) and INTERRUPT (C11) switches change the machining condition.

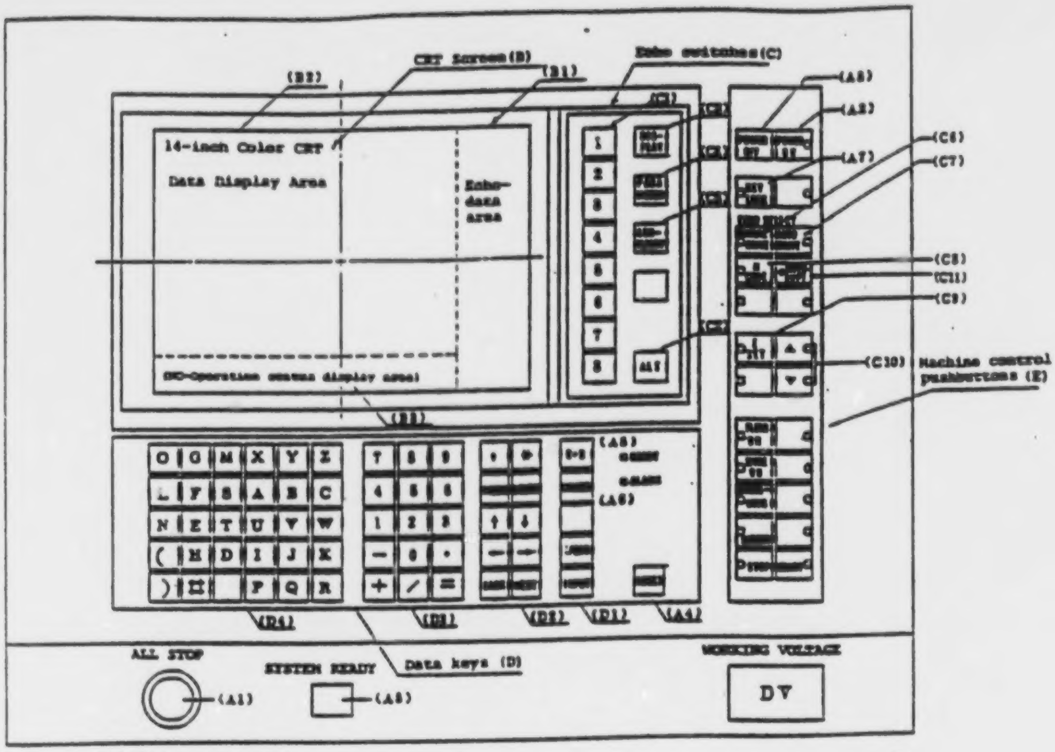
1

to

8

Echo data key group (C1)

When one of the echo keys, C3 through C9, is pressed, the corresponding menu appears in the echo-data area (B1) on the screen. The required menu item is selected by pressing the corresponding key (1 to 8) of the echo data group (C1). The selected item is then indicated in reversed red.


CRT Screen (B)
Echo switches (C)
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(B1)
(C1)
(C2)
(C3)
(A8)
(A2)
(C6)
(C7)
(A7)
14-inch Color CRT
Data Display Area
Echo-data area
(C8)
(C11)
(C9)
(C10)
Machine control pushbuttons (E)
NC-Operation status display area
(B3)
O G M X Y Z
L F S A B C
N E T U V W
(H D I J K
) P Q R
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1 2 3
− 0 .
+ / =
(A5)
(A6)
1 2 3 4 5 6 7 8
ALT
(D4)
(D3)
(D2)
(D1)
(A4)
Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A3)
WORKING VOLTAGE
DV

ALT key (C2)

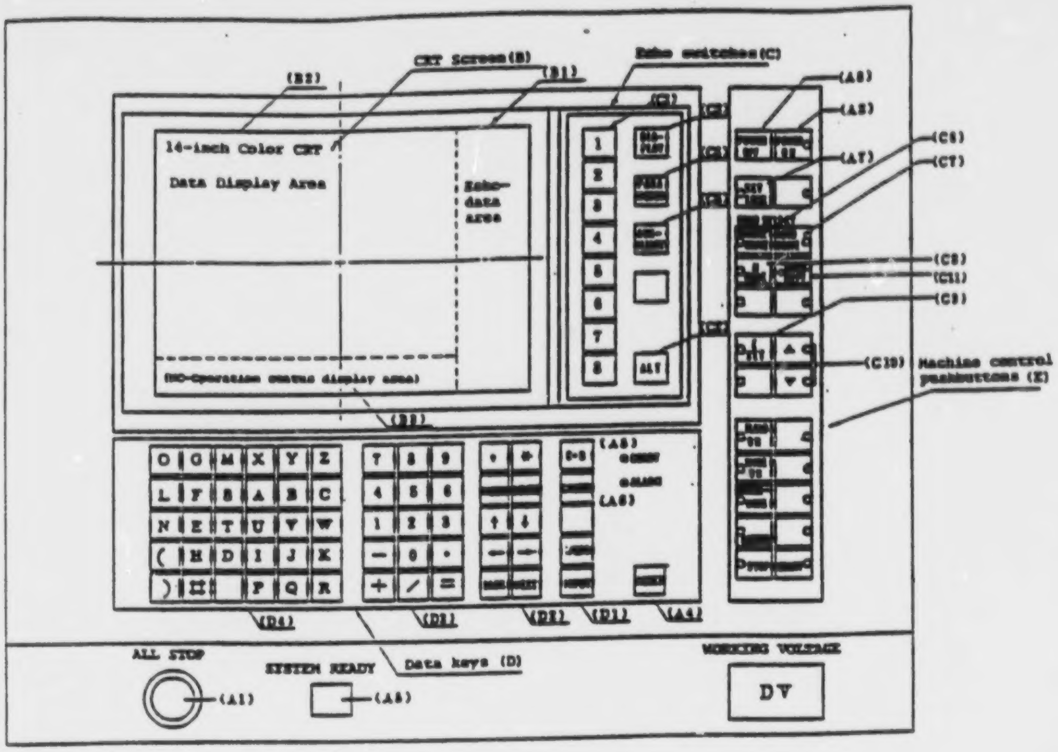
ALT

When one of the echo keys, C3 through C9, is pressed, up to 16 menu items may appear in the echo-data area (B1). Two menu items, upper and lower, correspond to each key of echo-data key group (C1). The ALT key is used to select either the upper or lower menu item of the pair selected by a key in the echo data key group (C1). The selected menu item, upper or lower, is indicated in yellow.

DIS-PLAY

DISPLAY key (C3)

When the DISPLAY key is pressed, the main menu (nine main menu items) appears in the echo-data area (B1). These menu items are used to select the content to be displayed in the data area (B2). The DISPLAY switch (C3) simply displays the main menu in the echo-data area (B1) and does not change the content of the data area (B2). The reversed-red menu item indicates the content appearing in the data area (B2). When a key (1 to 8) in the echo data group (C1) is pressed, the corresponding sub-menu appears in the echo-data area (B1). The reversed-red sub-menu item indicates the content appearing in the data area (B2). To change the content of the data area (B2), therefore, press the key (1 to 8) in the echo data group (C1) that corresponds to the desired sub-menu item.


CRT Screen(B)
Echo switches(C)
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(B1)
(C1)
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Machine control pushbuttons (E)
14-inch Color CRT
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O G M X Y Z
L F S A B C
N E T U V W
(H D I J K
) P Q R
7 8 9
4 5 6
1 2 3
− 0 .
+ / =
(A3)
(A6)
(D4)
(D3)
(D2)
(D1)
(A4)
ALL STOP
(A1)
SYSTEM READY
(A5)
Data keys (D)
WORKING VOLTAGE
DV

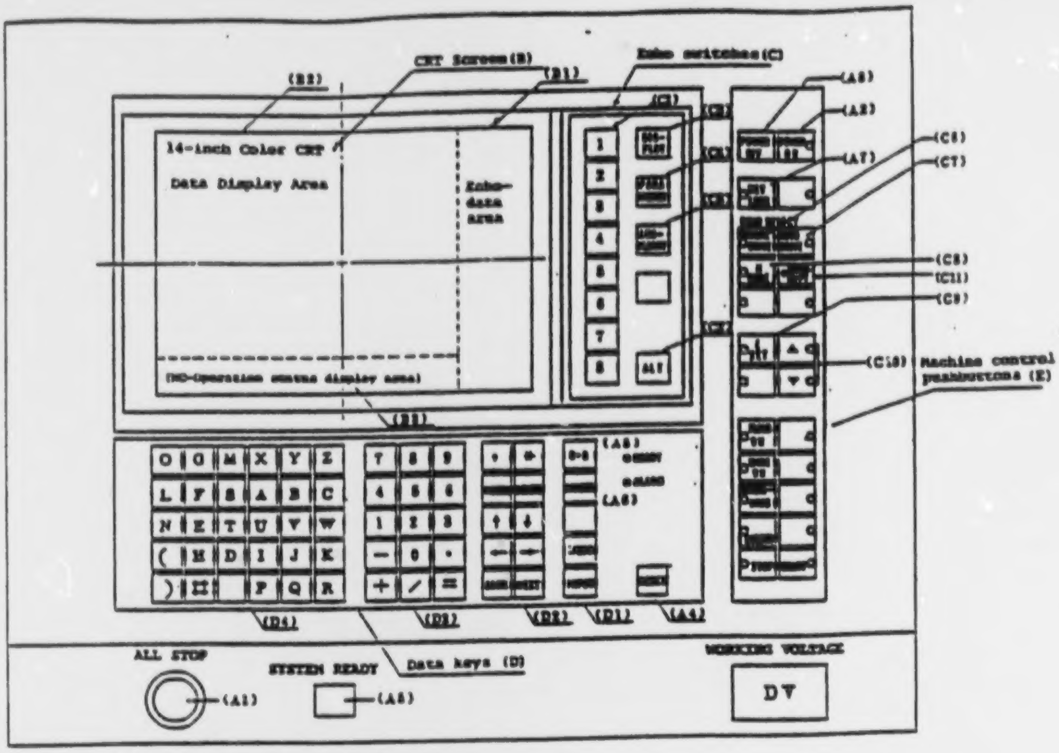
Selection of the data area (B2) content may be summarized as follows:

(1) Press the DIS-PLAY key (C3) to display the main menu in the echo-data area (B1).

(2) Press a key (1 to 8) in the echo data group (C1) to display a sub-menu in the echo-data area (B1).

(3) Press a key (1 to 8) in the echo data group (C1) to select the required content of the data area (B2).

If the main menu or the required sub-menu appears in the echo-data area (B1), the operation can begin with step (2) or (3).


CRT Screen(B)
Echo switches(C)
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14-inch Color CRT
Data Display Area
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Machine control pushbuttons (E)
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(D2)
(D1)
(A4)
Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A5)
WORKING VOLTAGE
DV

PARA METER

PARAMETER key (C4)

This key displays in the echo-data area (B1) the parameter menu related to the NC program.

AUX-ILIARY

AUXILIARY key (C5)

This key displays in the echo-data area (B1) the NC auxiliary function setting menu needed to set the machining operation status.

MANUAL DRIVE

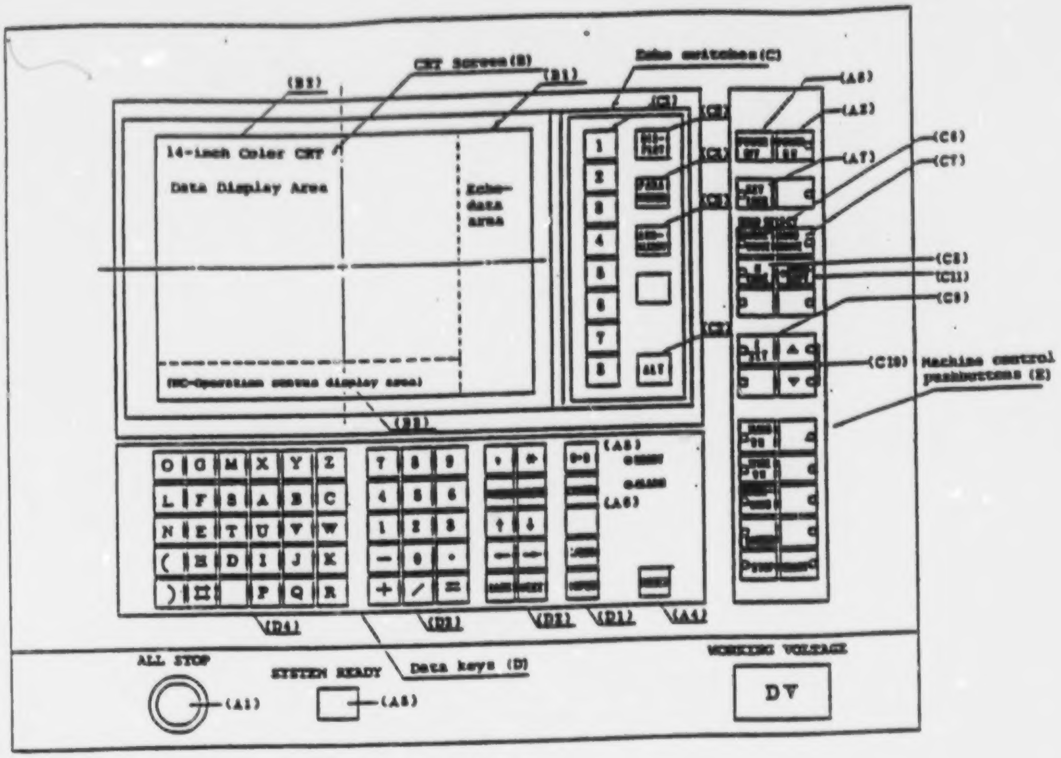
MANUAL DRIVE key and lamp (C6)

This key sets the manual mode. It also displays in the echo-data area (B1) the manual-mode operation menu for manual feed, center positioning, etc. The lamp indicates whether the manual mode is active (lit means active).

AUTO DRIVE

AUTO DRIVE key and lamp (C7)

This key sets the automatic mode. It displays in the echo-data area (B1) the menu needed to select operations related to the tape and memory in automatic operation. The lamp indicates whether automatic mode is active.


CRT Screen (B)
Echo switches (C)
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(NC-Operation status display area)
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Data keys (D)
ALL STOP
(A1)
SYSTEM READY
WORKING VOLTAGE
DV
ALT

M CODE

M CODE key and lamp (C8)

This key displays the M-function menu in the echo-data area (B1). The lamp indicates whether the M-function setting menu is currently in the echo-data area (B1).

E SET

E SET key and lamp (C9)

This key displays the machining condition setting menu in the echo-data area (B1). The lamp indicates whether the machining condition setting menu is currently in the echo-data area (B1).

▲

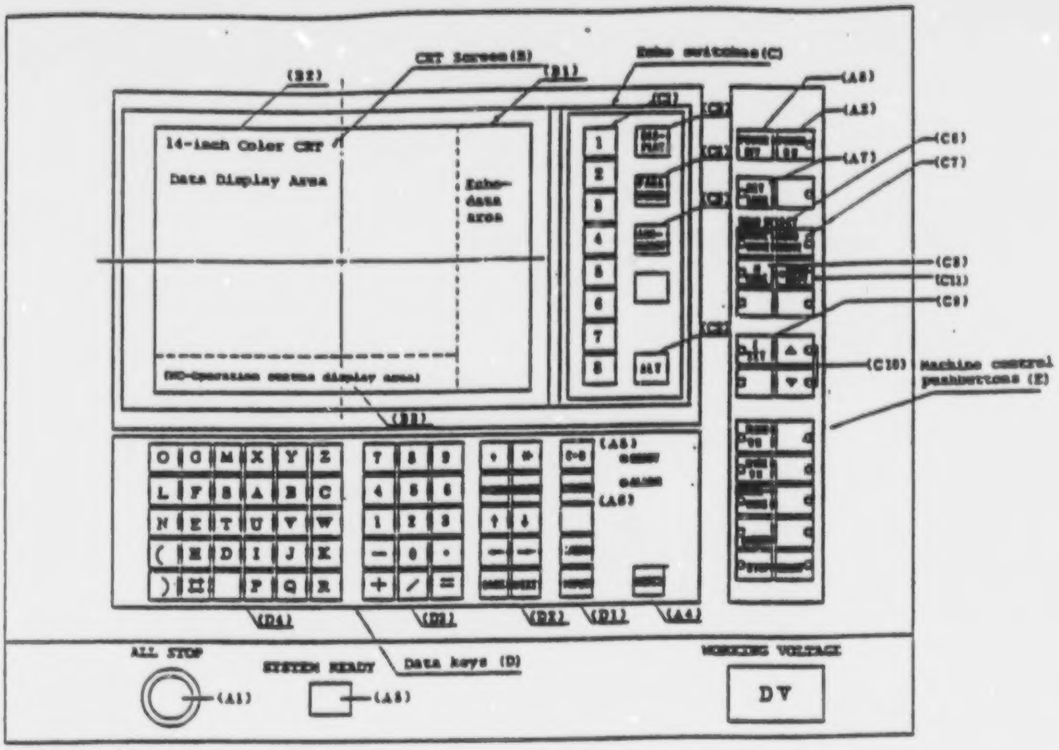
▼

▲ , ▼ keys and lamps (C10)

When the machining condition setting menu is displayed in the echo-data area (B1), these keys are used to increment or decrement the reversed-red machining data. If the ▲ or ▼ key is pressed to change the data outside the allowable range, the value does not change.

INTER-RUPT

The INTERRUPT (C11) key displays the machining condition at that instant. Mainly used to change the machining speed, F, midway through the operation.


CRT Screen(B)
Echo switches(C)
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(A8)
(A2)
(C6)
(A7)
(C7)
14-inch Color CRT
Data Display Area
Echo-data area
(NC-Operation status display area)
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(C10) Machine control pushbuttons (E)
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(A4)
ALL STOP
(A1)
SYSTEM READY
(A3)
Data keys (D)
WORKING VOLTAGE
DV

(D) Data keys

The address, data, special code, operation, and control keys are arranged in key groups D1 to D4.

- o Address keys

A to Z (26 alphabetic characters)

- o Data keys

0 to 9 (10 numeric characters) + - ·

- o Special code keys

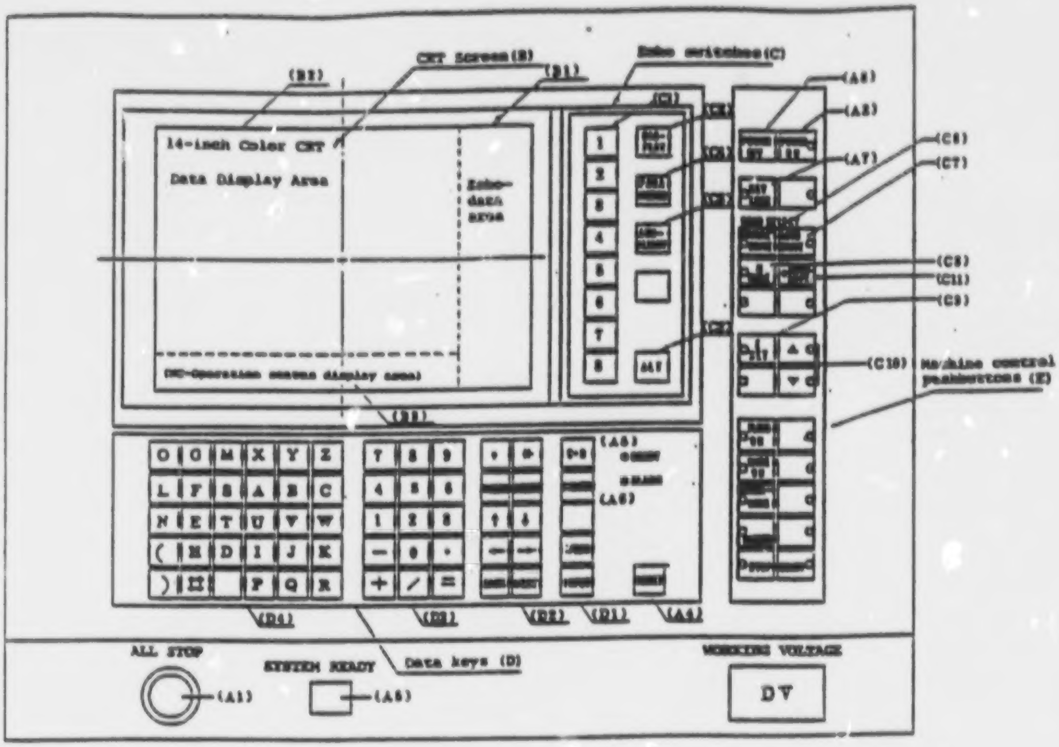
/ = * :/EOB ( )

- o Operation keys

NEXT BACK ← → ↑ ↓

- o Control keys

INSERT DELETE C·B CANCEL INPUT


CRT Screen (B)
Echo switches (C)
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Machine control pushbuttons (E)
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(A6)
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(D1)
(A4)
Data keys (D)
ALL STOP
(A1)
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(A5)
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DV

WIRE ON

WIRE ON key

This key is used to feed the wire at a given tension before machining begins.

FLUID ON

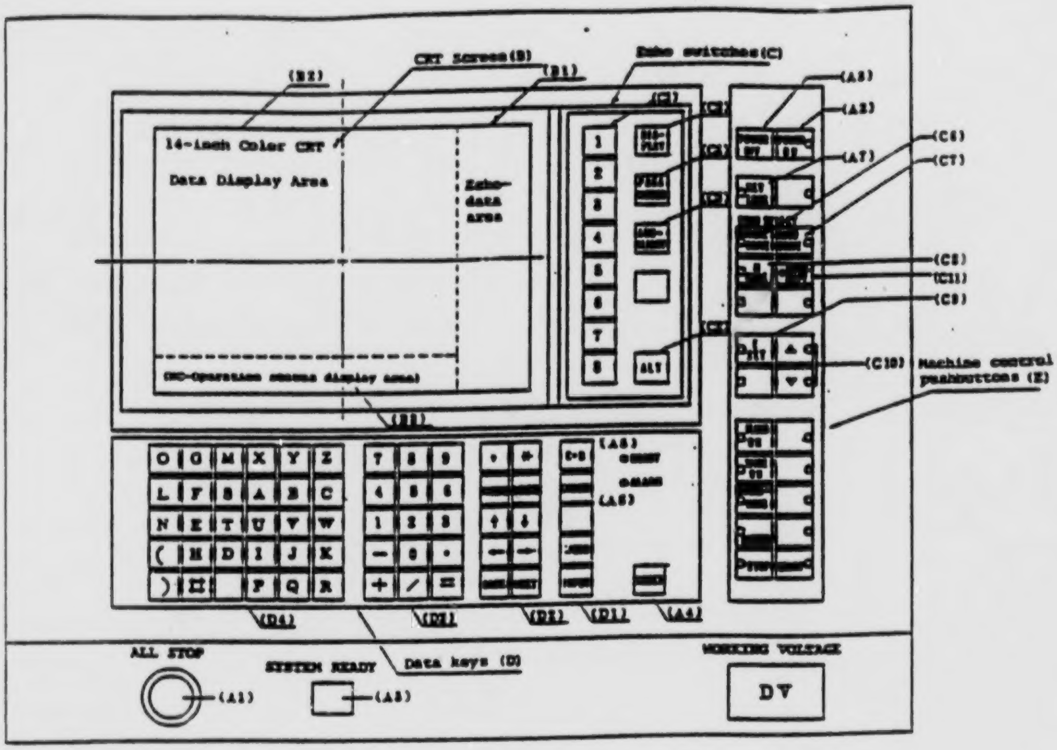
FLUID ON key

This key is used to feed the machining fluid. When the FLUID ON key is pressed, machining fluid begins flowing and the lamp lights. When the key is pressed again, the fluid stops.

MACHI-NING

MACHINING key

This key is used to apply a voltage across the wire electrode and workpiece to prepare for discharge machining.


CRT Screen(B)
Echo switches(C)
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(D2)
(D1)
(A4)
Data keys (D)
ALL STOP
(A1)
SYSTEM READY
(A3)
WORKING VOLTAGE
DV

BUZZER

BUZZER key

When the BUZZER key is pressed, its lamp lights. In this condition, the buzzer sounds when the wire breaks or when M02 or M30 reaches the end of the machining.

STOP

STOP key

This key is used to stop the NC program execution midway in the automatic mode (feed hold).

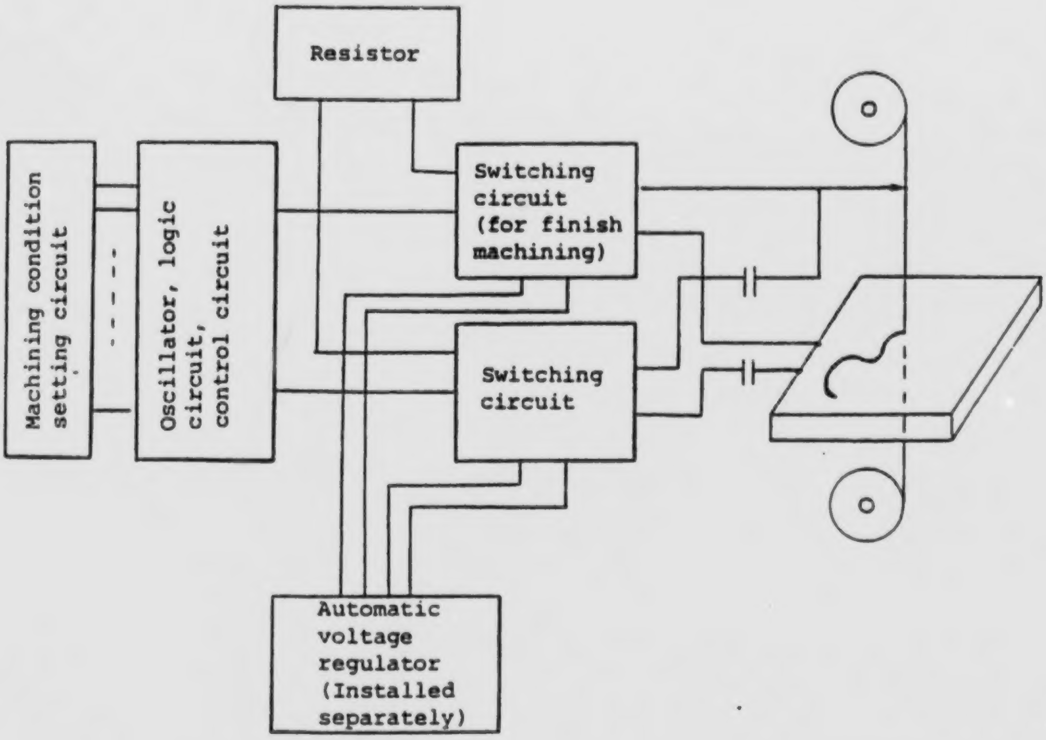
START

START key

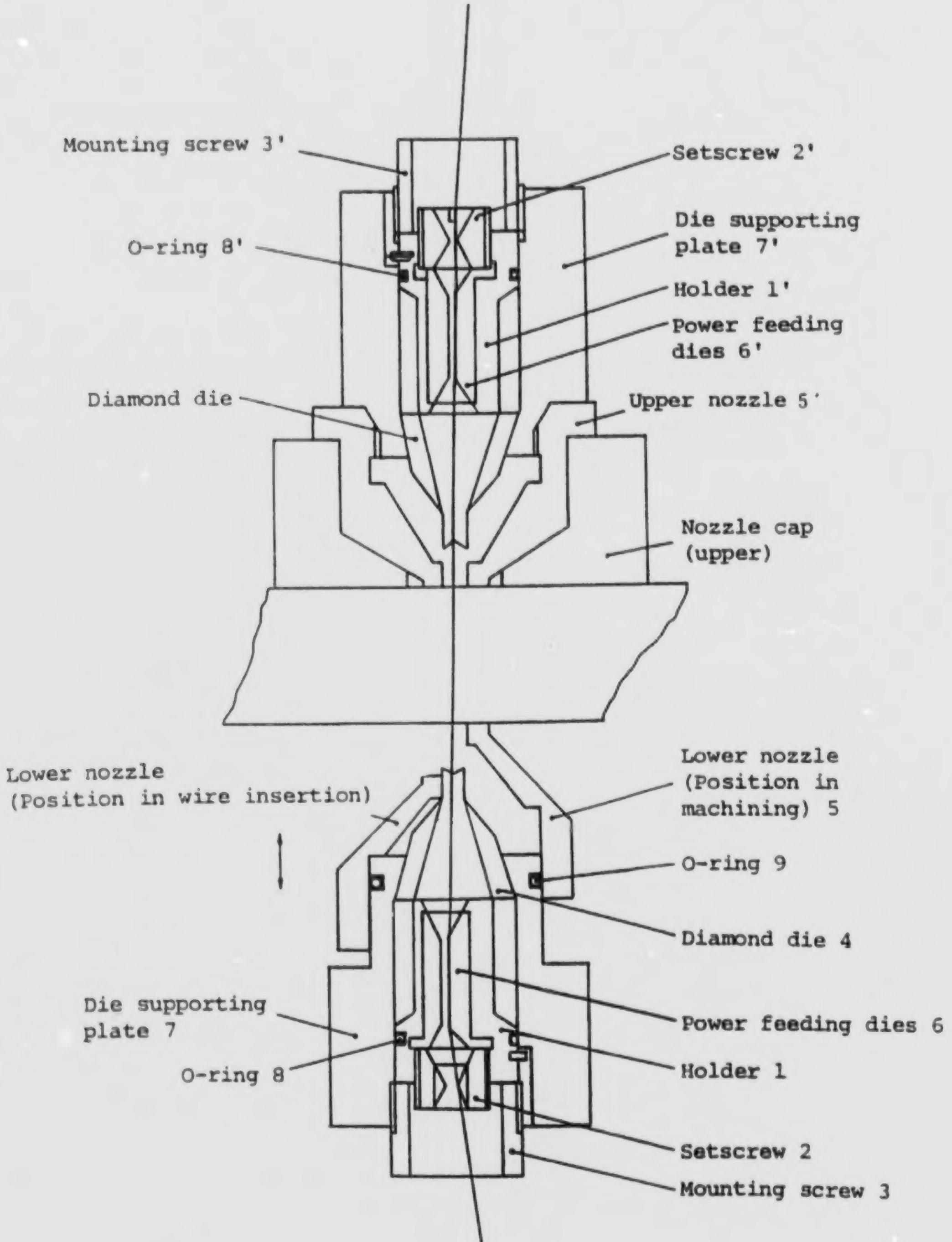
This key initiates an automatic operation. When the START key is pressed, its lamp lights and automatic operation begins. The key is also used to start a single-block operation (NC program execution block by block).

BASIC CIRCUIT CONFIGURATION

The power supply unit is a solid-state unit that employs a large capacity, high-speed switching transistor in the switching circuit. The circuit system, which has no interpole capacitor, controls discharge pulses directly to suit the interpole condition and supplies the pulses to the interpole for the best machining efficiency. Thus this power supply unit an all-around necessity for wire-cut EDM, giving not only high-speed machining performance but excellent characteristics in the machining speed versus surface roughness.


Resistor
Machining condition setting circuit
Oscillator, logic circuit, control circuit
Switching circuit (for finish machining)
Switching circuit
Automatic voltage regulator (Installed separately)

Wire Guide Construction


Mounting screw 3'
Setscrew 2'
Die supporting plate 7'
O-ring 8'
Holder 1'
Power feeding dies 6'
Diamond die
Upper nozzle 5'
Nozzle cap (upper)
Lower nozzle (Position in machining) 5
Lower nozzle (Position in wire insertion)
O-ring 9
Diamond die 4
Die supporting plate 7
Power feeding dies 6
O-ring 8
Holder 1
Setscrew 2
Mounting screw 3

Notes:

Unit 22

Intoduction

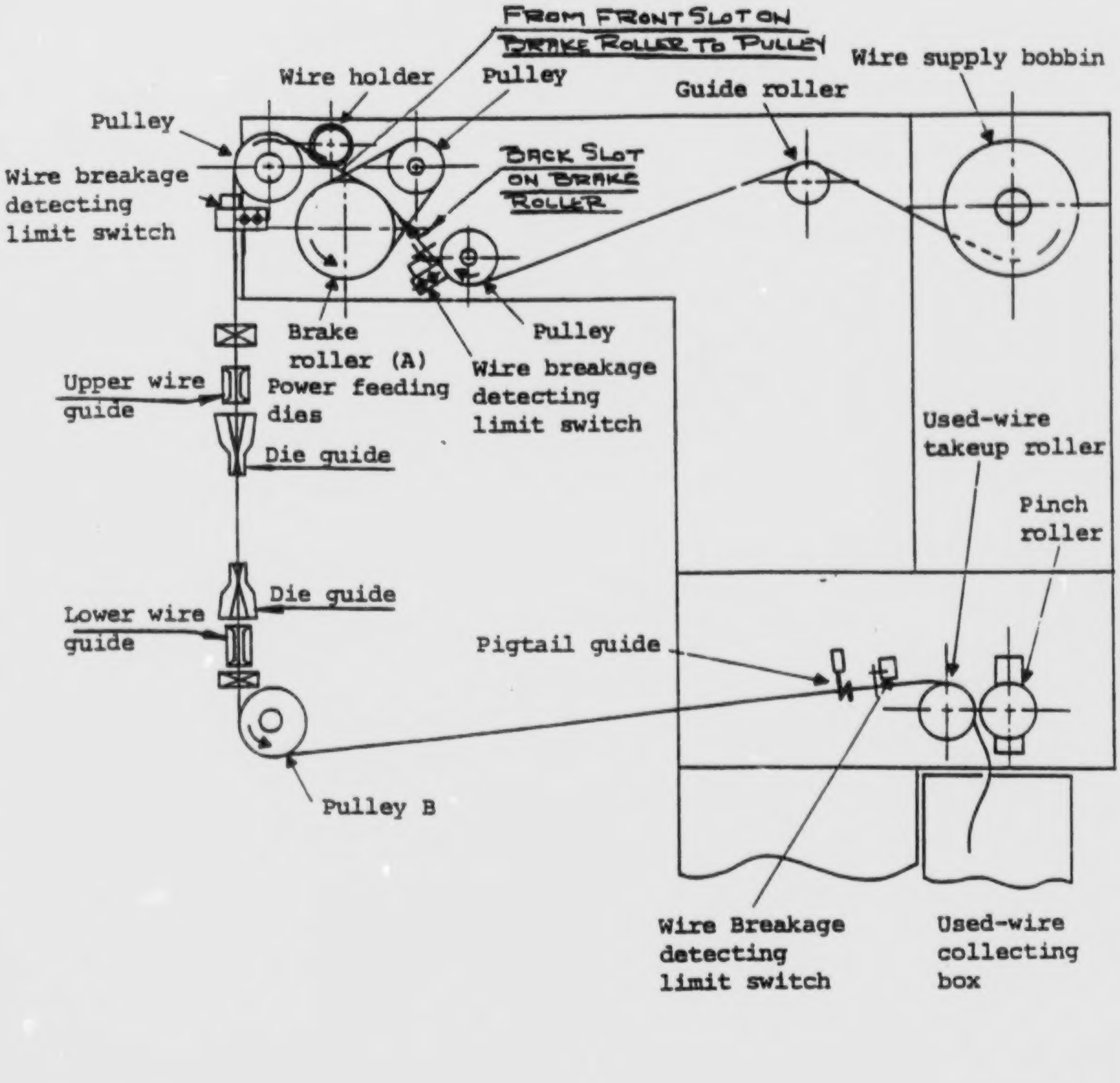
A part will be setup in the wire EDM starting with installing the wire and being complete by burning out a part.

Objectives

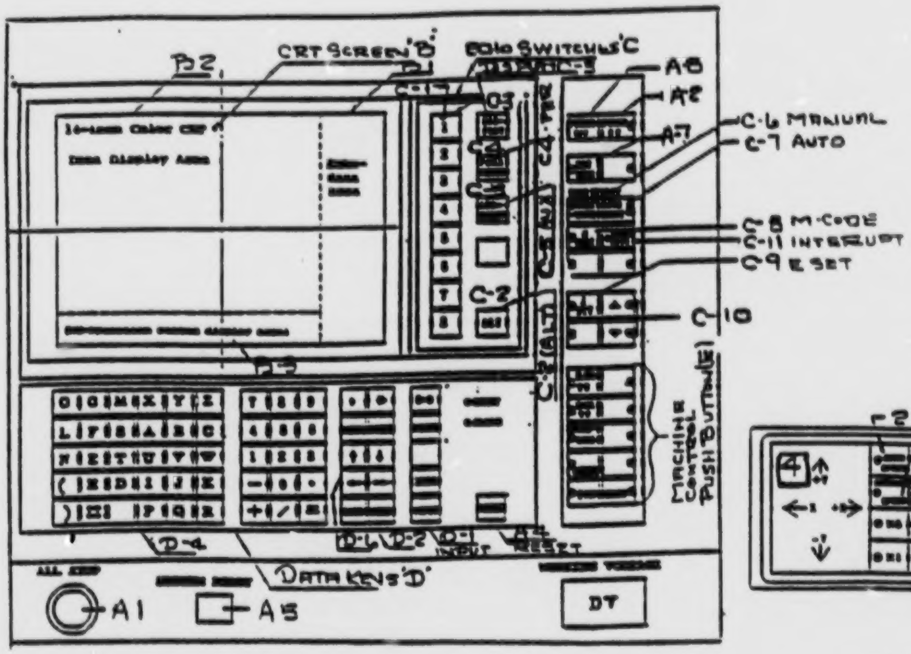
Upon successful completion the trainee will be able to:

1. Install the electrode wire into the machine.
2. Find programs in memory.
3. Label programs.
4. Pull programs from memory.
5. Plot a part on the machine.
6. Mount part on table using proper precaution.
7. Pick up edge of part for location.
8. Pick up center of hole for location.
9. Set wire offset.
10. Enter proper E-SET values into the machine.
11. Set upper guide to proper height.
12. Set up graphics to observe location of part while it is running.

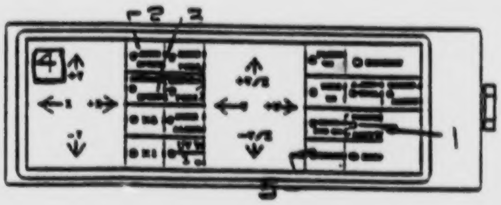
WIRE INSTALLITION DWC 90


FROM FRONT SLOT ON BRAKE ROLLER TO PULLEY
Wire holder
Pulley
Guide roller
Wire supply bobbin
Pulley
Wire breakage detecting limit switch
BACK SLOT ON BRAKE ROLLER
Brake roller (A)
Pulley
Wire breakage detecting limit switch
Upper wire guide
Power feeding dies
Die guide
Used-wire takeup roller
Pinch roller
Die guide
Lower wire guide
Pigtail guide
Pulley B
Wire Breakage detecting limit switch
Used-wire collecting box

SETTING UP THE WIRE EDM


B2
CRT SCREEN 'B'
B1
EDIO SWITCHES 'C'
C-3
C-1
C-5
A-8
A-2
A-7
C-6 MANUAL
C-7 AUTO
C4 PRG
C-3 AUX
C-8 M-CODE
C-11 INTERRUPT
C-9 E SET
C-2
C-10
C-2 (ALT)
B-3
MACHINE CONTROL PUSH BUTTON (E)
D-4
D-1
D-2
D-1 INPUT
A-4 RESET
DATA KEYS 'D'
A1
A5
DT

C.R.T. Figure 1



MANUAL BOX Figure 2

1. Press key lock button **A-7** (red light should be off).

2. Turn on power.

    A. Turn red stop button **A-1** clockwise to release.

    B. Push system **READY** button **A-5**; machine will turn on.

3. Using manual box to move table.

    A. Push **MANUAL**, auto button **#1** manual (light should be on)

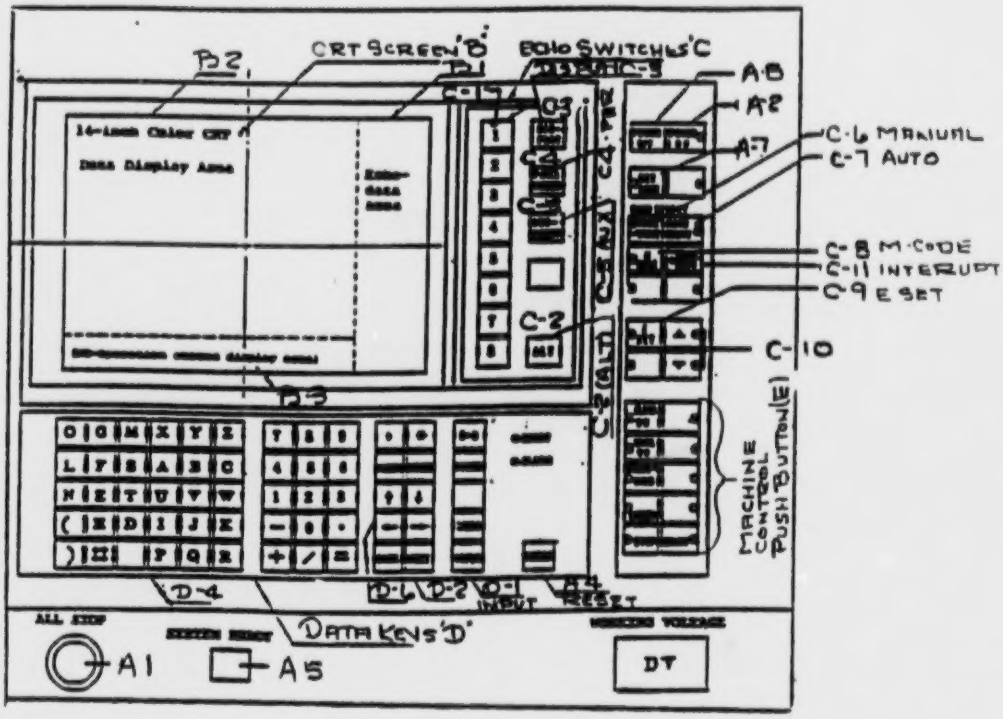
    B. Push **HIGH** speed or **MEDIUM** speed button **#2** or 3. This will give you the table movement speed you may require.

    C. Push arrow button **#4**, [-X], [+X], [-Y], or [+Y] to move table in required direction

4. Go back to CRT screen

5. Push Display button **C-3**, a list of 8 items will appear on the right side of the CRT. On the part we are going to make, we will only use the following screens:

    (2) Parameter/user
    (3) Search
    (6) Graphic
    (8) Map


CRT SCREEN 'B'
ECHO SWITCHES 'C'
B2
B1
C-1
C-3
C-5
C3
C4 PRE
C-5 AUX
C-2
C-3 (ALT)
B3
A-8
A-2
A-7
C-6 MANUAL
C-7 AUTO
C-8 M-CODE
C-11 INTERUPT
C-9 E SET
C-10
MACHINE CONTROL PUSH BUTTON (E)
14-inch Color CRT
Data Display Area
D-4
D-6
D-2
D-1 INPUT
A-4 RESET
DATA KEYS 'D'
ALL STOP
A1
A5
DT

6. Push Map button #8 (the screen will list all the programs in memory by number) To go from one screen to the next or previous screen, push the **BACK** or **NEXT** button #D-2.

7. Look for your program number.

*At this point we have already manually programmed or medi-apt programmed part and have it in the memory of the machine.

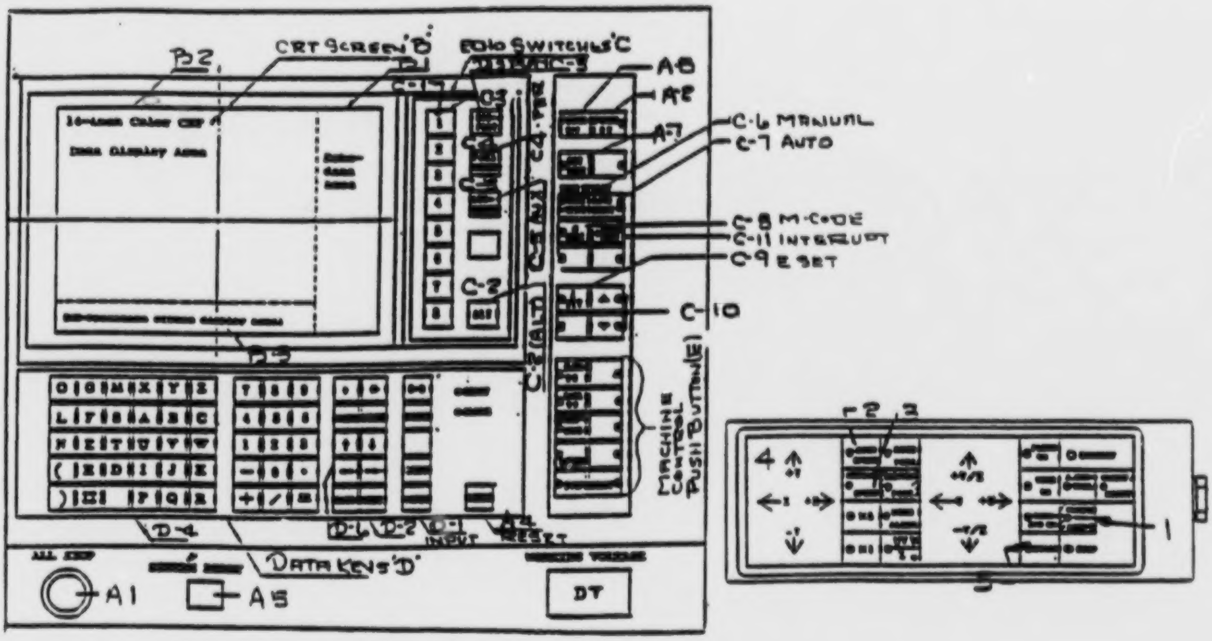
8. Label your program with a name (use your name so that instructor knows, or can identify programs in memory.

    A. Cursor will be flashing at lower left of the CRT. Enter your program number to the right of the word label (if you make a mistake you can cursor back using the arrow keys D-6).

    B. Enter your name to the right of the word Comments (cursor over if necessary).

    C. Push input button **D-1**.

9. Push **DISPLAY** button **C-3**.


B2
CRT Screen 'D'
Edit Switches 'C'
A8
A2
A7
C-6 MANUAL
C-7 AUTO
C-8 M-CODE
C-11 INTERRUPT
C-9 RESET
C-10
C-3
C-2 (ALT)
10-inch Color CRT
Data Display Area
MACHINE CONTROL PUSH BUTTON(E)
D-4
DATA KEYS 'D'
D-1
D-2
D-3 INPUT
A4 RESET
A1
A5
DT
4
2
3
1
5

10. Push Search button #3 (search screen will appear on CRT).

    A. Cursor will be flashing at lower left of screen. If there is a number where cursor is flashing push reset button #A4. This is necessary to remove previous program.

    B. Enter an **M** or **T** where cursor is flashing. (M is for memory, T is for tape).

    C. Enter your part numbers.

    D. Push **INPUT** button.

11. The next step is to plot the part to check out your program. **Note!** if you are **sure** your program is correct this step is not necessary.

    A. Push auxiliary button **C-5**.

    B. Push key #3, plot (plot will light up in red along side key and also on lower left of CRT).

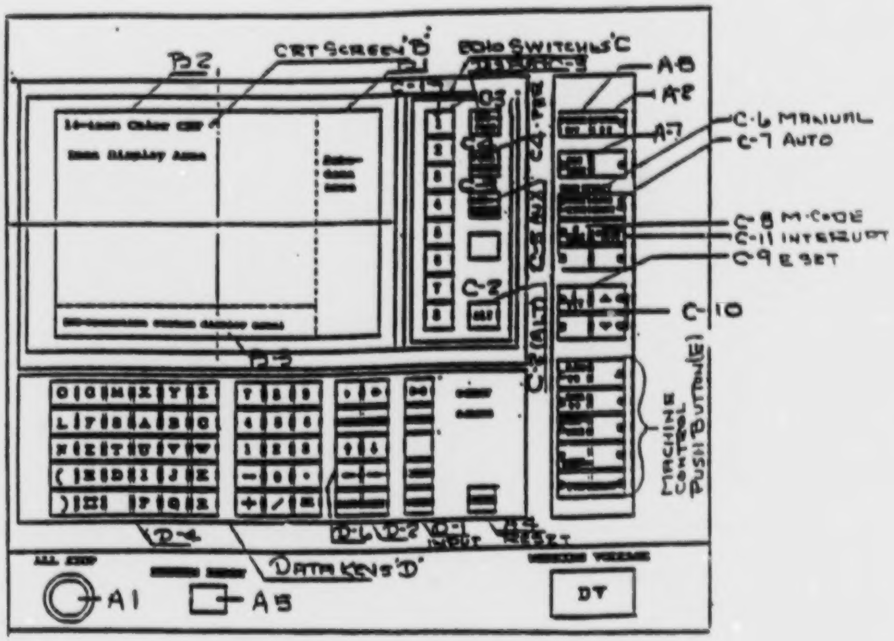
    C. Move table so that the wire is toward the center of the table (allow enough room to plot your part so that you do not run out of table travel) To move table the following steps are taken:

        1. Press auto - manual button #1 on manual box. (light should be on)

        2. Push **HIGH** speed or **MEDIUM** speed button #2 or 3.

        3. Push arrow key #4 to move table in required direction.

        4. Press **AUTO/MANUAL** button #1. (light should be off).


D2
CRT SCREEN 'D'
D1
EDIT SWITCHES 'C'
C-5
D3
A6
A8
A7
C-6 MANUAL
C-7 AUTO
C4 PRE
C-3 AUX
C-8 M-CODE
C-11 INTERRUPT
C-9 RESET
C-2
C-10
C-2(ALT)
D-3
MACHINE CONTROL PUSH BUTTONS(E)
D-4
DATA KEYS 'D'
D-1
D-2
D-1 INPUT
A-2 RESET
A1
A5
DT

D. Push start key #5 on manual box.
Note! Plot shown will be just opposite (180°) of what it was layed out on medi-apt or how it will burn.

E. If plot is correct go back to auxiliary and **turn off plot keys**. If it is not correct see your instructor.

12. Mount and indicate part on table using high or medium speed* arrow buttons. See the following page for mounting instructions.*

A. Decide where to mount part on table front, back, left, or right. Keep in mind that it will burn just the way you have programmed it on the medi-apt but just **opposite** of what it has plotted.

*When mounting check the following items:

B. Check that clamps are back far enough to clear upper guide head as it moves to burn part.

C. **Do not** have part extending below table surface or it will hit lower flushing cup.

D. Check to be sure you do not run out of table travel. Table will automatically stop when wire is approximately .350 table.

E. See your instructor if you are undecided on how and where to clamp part.

13. Check wire alignment. Wire alignment is usually good but if you are not sure see (automatic wire alignment) or check with your instructor.

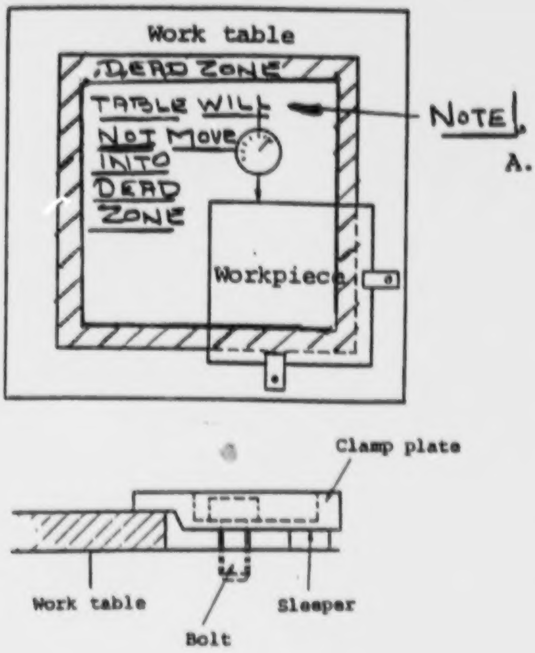

Work table
DEAD ZONE
TABLE WILL NOT MOVE INTO DEAD ZONE
NOTE!
Workpiece
Clamp plate
Work table
Bolt
Sleeper

Figure 1

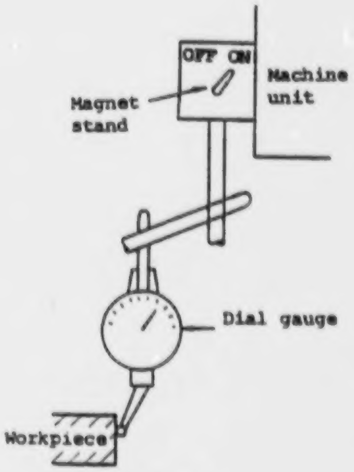

OFF ON
Magnet stand
Machine unit
Dial gauge
Workpiece

Figure 2

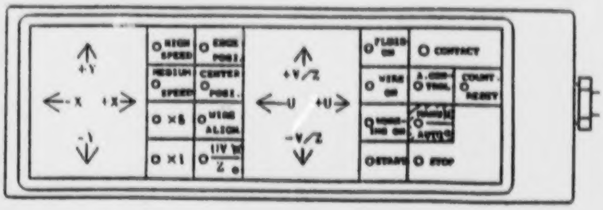

+Y
-X
+X
-Y
HIGH SPEED
MEDIUM SPEED
×5
×1
CENTER POSI.
WIRE ALIGN.
+V/Z
-U
+U
-V/Z
FLUID ON
CONTACT
WIRE ON
START
STOP

Figure 3)

A. Workpiece installation and parallelism adjustment

1. Fasten a workpiece lightly to the work table using clamp plates (see Figure 1)

2. Put a magnet stand on the machine unit as shown in Figure 2

3. Press the DIS- PLAY pushbutton on the manual box to light the lamp (see Figure 3)

4. Select and press the ○HIGH SPEED, ○MEDIUM SPEED, ○ X5, or ○ X1 pushbutton to determine the table moving speed.

5. Press positioning pushbutton [+X], [-X], [+Y], or [-Y] to move the table in the desired direction.

   If the reference plane of the workpiece is inclined in the table moving direction, the dial guage pointer moves.

6. Lightly strike the workpiece with a copper hammer or the like to make the reference plane of the workpiece parallel to the table feed direction.

7. Tighten the clamp plates to secure the workpiece.

14A. To pick up edge of part or block see example.

A. Move wire position shown in Figure 4. Approximately 1/4" from edge.

B. Push **EDGE** position button **MANUAL BOX.**

C. Wait a few seconds.

D. Push arrow key [+X] to move to edge.

E. Wait until position end is lighted on CRT. **Note!** wire contact light will flash on and off as it is finding position.

F. Go to CRT and push **DISPLAY**.

G. Push button **#2** parameter user screen.

H. "O" out REL-POS.

   1. Push **X** on key board.

   2. Push **C-B** key.

I. Move wire to position.

J. "B" Figure (4).

K. Move [+X] 2.00 to position C.

L. Push **EDGE** position button.

M. Wait a few seconds.

N. Push [-Y] arrow key and repeat steps E to H for Y position.

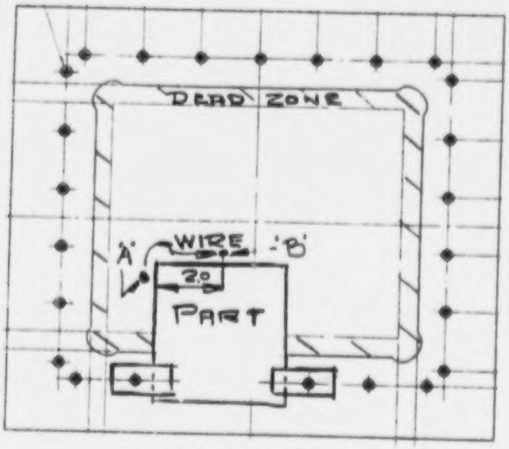
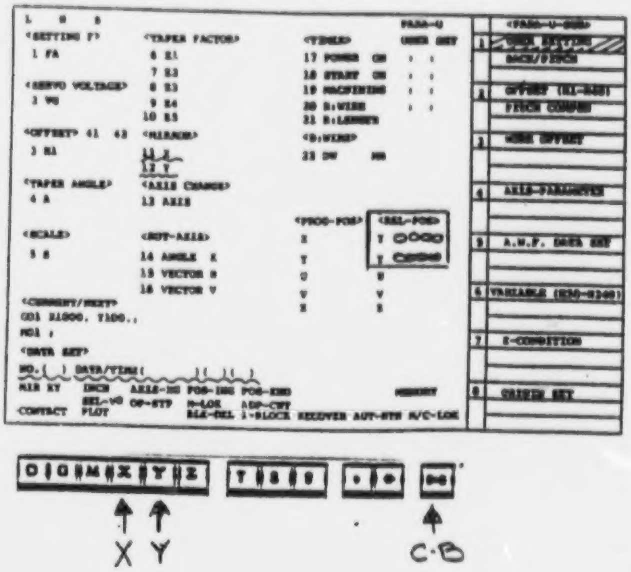


FIGURE 4



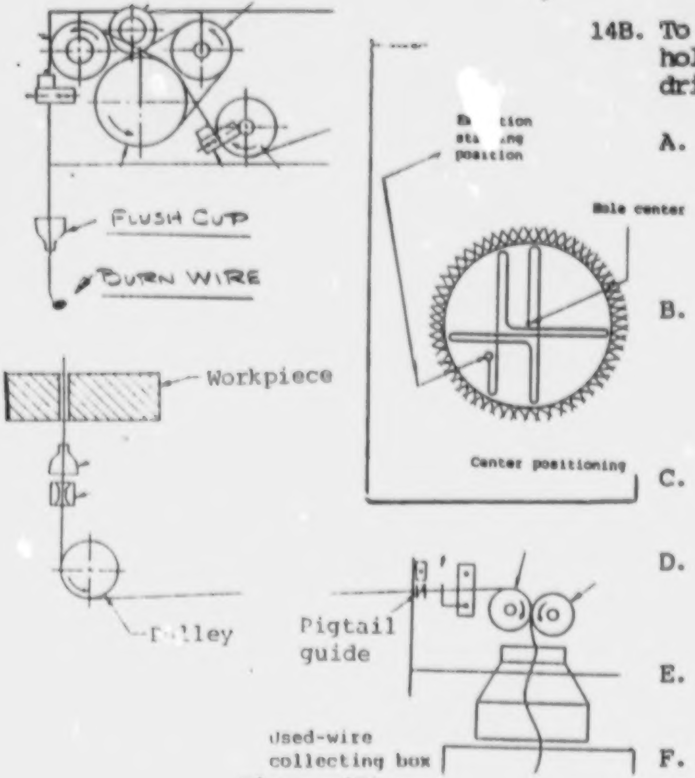

FLUSH CUP
BURN WIRE
Workpiece
Pulley
Execution starting position
Hole center
Center positioning
Pigtail guide
Used-wire collecting box

Figure (5)

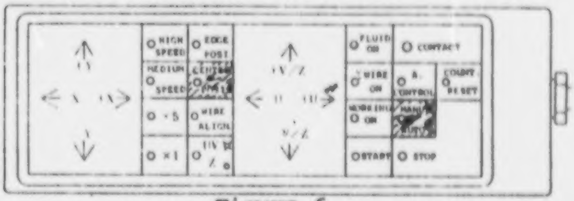
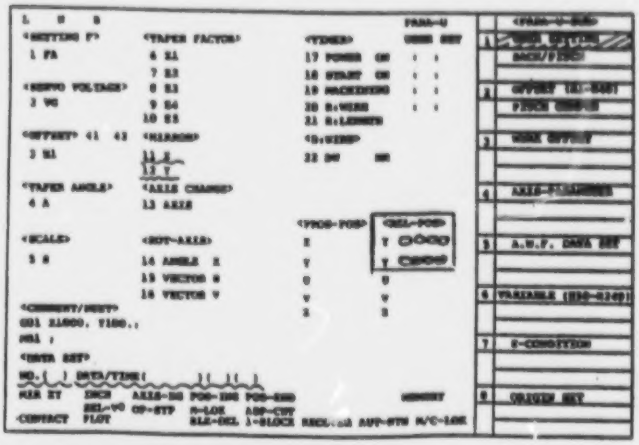
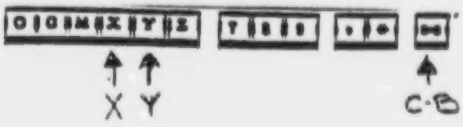

HIGH SPEED
MEDIUM SPEED
EDGE POSI
CENTER POSI
× 5
× 1
WIRE ALIGN
FLUID ON
CONTACT
WIRE ON
A. CONTROL
COUNT RESET
MACHINING ON
MANU AUTO
START
STOP
V/Z

Figure 6.


<SETTING F>
<TAPER FACTOR>
<TIMER>
<SERVO VOLTAGE>
<OFFSET>
<MIRROR>
<TAPER ANGLE>
<AXIS CHANGE>
<SCALE>
<ROT-AXIS>
<PROG-POS>
<REL-POS>
<COMMENT/NEXT>
<DATA SET>
MEMORY
WORK OFFSET
AXIS-PARAMETER
A.W.F. DATA SET
ORIGIN SET



14B. To pick up a hole in a part **Note!** the hole **must** be a smooth hole not just drilled.

A. Break wire just below upper flush cup Figure (5) it should be burned not cut, burning will eliminate the problem of a burr on the wire.

B. Feed wire through your premachined hole, through the lower flush cup and on to the wire box **Note!** You may need help from your instructor at this point.

C. Press the **MANU/AUTO** pushbutton on the manual box to light the lamp.

D. Press the **CENTER/POSI** pushbutton on the manual box to light the lamp as shown in Figure 6.

E. Wire feed is automatically switched on.

F. Press the [+X], [-X], [+Y], or [-Y] pushbutton.

G. Press the **COUNT/RESET** pushbutton on the manual box to light the lamp (see Figure 6)

H. Press either [+X] or [-X] to set 0 at X in the <REL-POS> column.

I. Press either [+Y] or [-Y] to set 0 at Y in the <REL-POS> column.

J. Press the **COUNT/RESET** pushbutton on the manual box to turn the lamp off.

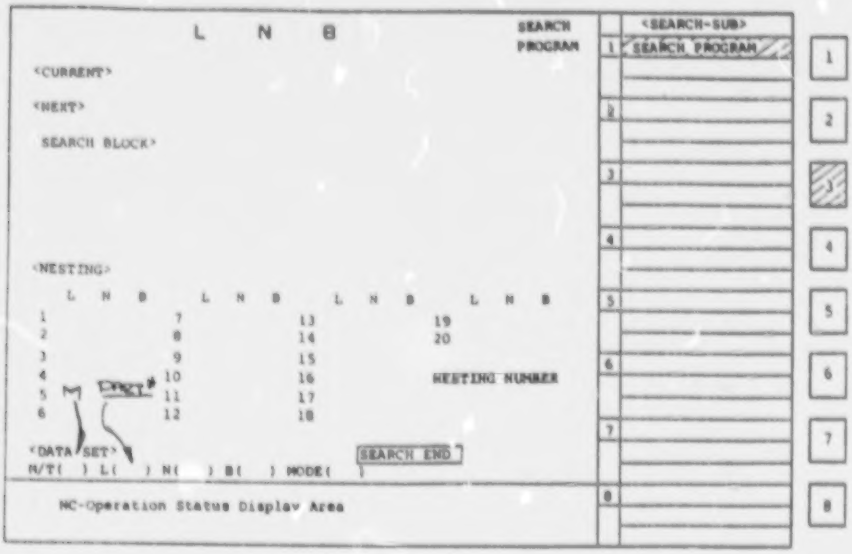
K. Repeat steps (5) to (8) above.

L. Check the X and Y values in the <REL-POS> column.

(Repeat steps (10) to (15) if either exceeds ±0.005.

M. Press the **RESET** pushbutton to reset the X and Y values to 0 in the PROG-POS column

ENTERING PROGRAM INTO MACHINE


L N B
SEARCH PROGRAM
<SEARCH-SUB>
SEARCH PROGRAM
<CURRENT>
<NEXT>
SEARCH BLOCK>
<NESTING>
NESTING NUMBER
<DATA SET>
M/T( ) L( ) N( ) B( ) MODE( )
SEARCH END
NC-Operation Status Display Area
1
2
3
4
5
6
7
8

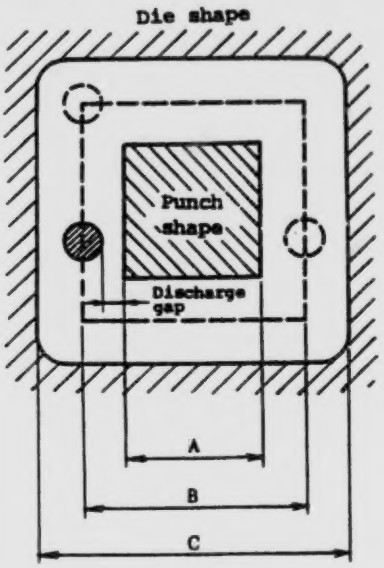
15 You are now ready to put your program into the machine and do your burning. The following steps should be taken (you should be in **MANUAL** mode)

1. Push **RESET** button **A-4.**
2. Push **DISPLAY** button **C-1.**
3. Push **#3 SEARCH** (cursor will be flashing at lower left hand corner).
4. Push **M** on keyboard for memory or **T** for tape.
5. Enter your **PART** or **JOB NUMBER**.
6. Push **INPUT** button **D-1**.
7. Push **DISPLAY** button **C-3.**
8. Push **#2 PARAMETER USER** button
9. On the parameter user screen take the following steps (cursor will be flashing at the lower left of CRT). See next page.
   - A. Push **#1** on keyboard.
   - B. Cursor over **one**, by pushing the **ARROW** key on keyboard.
   - C. Enter **.050** on keyboard.
   - D. Push **INPUT** key.
   - E. Number 2 will now appear at number. We will **not** change this.
   - F. Cursor back **one** space using arrow key on keyboard.

WIRE OFFSET

A die and punch are machined with the wire-cut EDM system as shown in Figure If the wire travels along the drawing dimensions (accurate dimensions), the die or punch dimensions change by a sum of the wire radius and discharge gap.

The punch becomes smaller than accurate dimensions by this sum and the die becomes greater by the sum. To obtain a punch of accurate dimensions, therefore, move the wire to the outside by the sum of the wire radius and discharge gap for machining. This moving distance is called an offset amount.

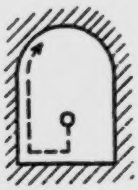


A: Punch dimension

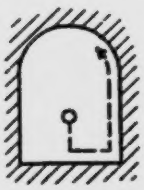
B: Drawing dimension (Accurate dimension)

C: Die dimension

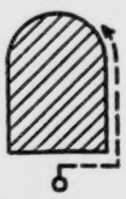
Offset direction must be entered wnen preparing a program.



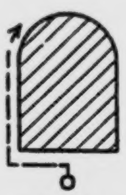
Offset direction (R or RG, G42 in NC language)



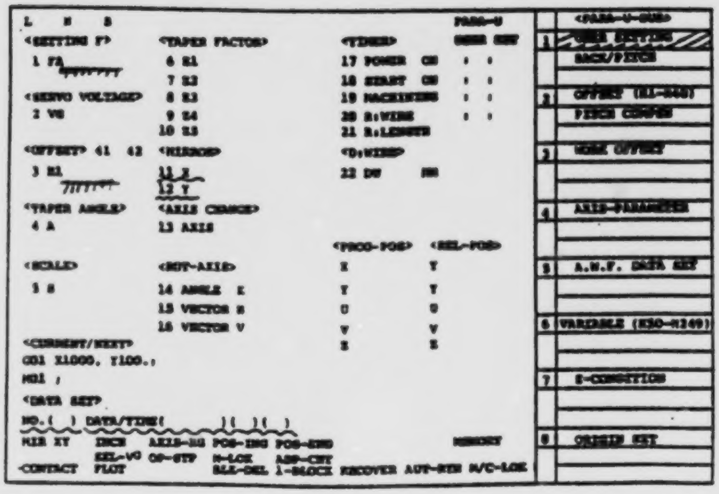
Offset direction Left (L or LF, G41 in NC language)



Offset direction Right (R or RG, G42 in NC language)



Offset direction Left (L or LF, G41 in NC language)



G. Enter #3 on keyboard.

H. You must now decide how much offset you require (1/2 of wire diameter plus overburn) The over burn would depend on several items. See your instructor for help at this point.

I. Enter proper offset value.

J. Push **INPUT** key.

K. Check offset direction 41 or 42 if you do not have the correct offset direction, you may want to use a value for offset. See your instructor.

L. If you are going to cut a taper (#4 taper angle) see unit on Taper.

M. Number 5(scale) is to reduce or increase size of part. This is not used very often and should remain at 1.00.

16 The next step is to set your E PACK number (the E PACK number will automatically give you all of the settings necessary to burn out the part. For an explanation of these settings see page

A. Check thickness of material.

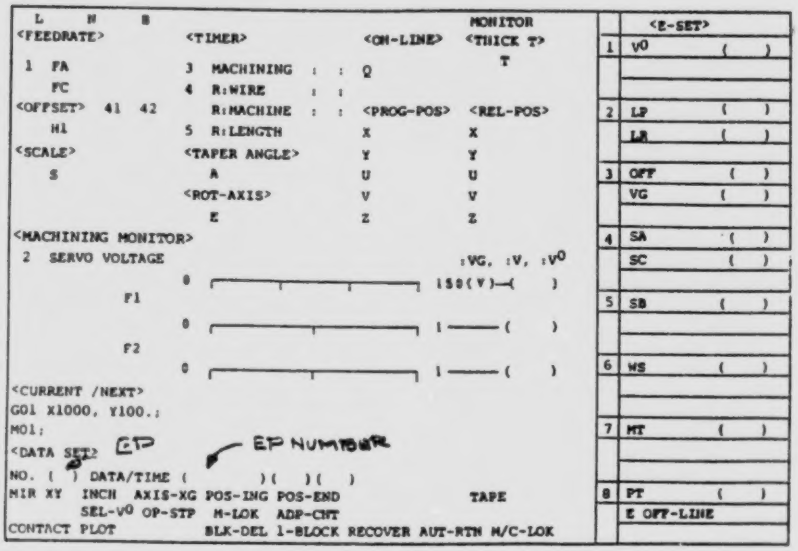
B. Compare material thickness with charts on pages 1 to 6 APPENDIX

C. Select proper setting.

D. Go to machine and push **INTERRUPT** button **C-11**.

E. Cursor will be flashing on lower left of CRT.

F. Enter **E** on keyboard (EP will appear).



```
 L      N      B                                              MONITOR
<FEEDRATE>          <TIMER>                    <ON-LINE>   <THICK T>
                                                              T
 1  FA              3  MACHINING   :   :   Q
    FC              4  R:WIRE      :   :
<OFFSET>  41  42       R:MACHINE   :   :   <PROG-POS>   <REL-POS>
    H1              5  R:LENGTH            X            X
<SCALE>             <TAPER ANGLE>          Y            Y
    S                  A                   U            U
                    <ROT-AXIS>             V            V
                       E                   Z            Z
<MACHINING MONITOR>
 2  SERVO VOLTAGE                                   :VG,  :V,  :V0
                    0                            150(V)—(      )
              F1
                    0                            1 ———— (      )
              F2
                    0                            1 ———— (      )
<CURRENT /NEXT>
G01 X1000, Y100.;
M01;
<DATA SET>
NO. (  ) DATA/TIME (          )(    )(    )
MIR XY   INCH  AXIS-XG POS-ING POS-END                  TAPE
         SEL-V0 OP-STP  M-LOK  ADP-CNT
CONTACT PLOT           BLK-DEL 1-BLOCK RECOVER AUT-RTN M/C-LOK
```

	<E-SET>
1	V0 ( )
2	LP ( )
	LR ( )
3	OFF ( )
	VG ( )
4	SA ( )
	SC ( )
5	SB ( )
6	WS ( )
7	MT ( )
8	PT ( )
	E OFF-LINE

G. Enter proper EP number from chart.

H. Push **INPUT** button

I. At this time you will notice all the electrical settings are at the left of CRT, one of them will be highlighted. If you want to change any of these settings the following steps should be taken.

1. Push number to the right of the description on your CRT (1-8) the number will now be highlighted.

2. Use arrow keys along side of **E** set button to raise or lower number.

Note! "E" PACK can also be set on your parameter <u>user</u> screen.

1. Push **"E"** on keyboard (EP will apprear)

2. Enter proper EP number.

3. Push **INPUT** key.

4. You will notice that there are no electrical settings listed when using the <u>parameter</u> user screen.

Note! If you would like to change any setting during operation you can push either the interrupt button or the E set button and make any changes.

When the machine has cut into the part approximately 1/8 inch, you should change the E number to the setting given on the chart. Use the same method as you used to set the starting E PACK. **<u>But first to step 11.</u>**

17 You are now ready to prepare the table area for burning.

A. Loosen clamp which holds the upper head in place. Figure 6.

Note! Be sure to hold onto knob A when loosening clamp.

B. Bring head down to cutting positon using .004 shim to set head height. Figure 7.

1. Double check to be sure you will not hit any o lamp or other objects while you are moving to do the burning.

2. Be sure nothing is extending below the table level or you will break or damage the lower head.

C. Put front cover in place Figure 8.

D. Put plastic guards in place.

E. Be sure folding door is closed where wire comes out from under table.

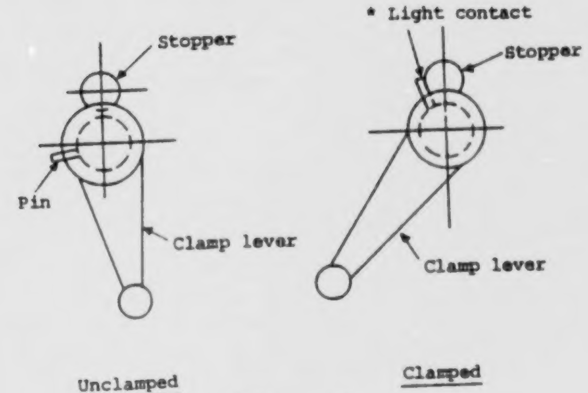
18 See your instructor to have him check your setup.

19 Go to manual box and push **MANU/AUTO** button to auto (light should be off).

20 Push **START** button and machine will start to burn.

Note! If sometime during the machining cycle it is necessary to turn the machine off, you __cannot__ just push the start button to restart the machine you must push -

1. **Fluid** on (See next page)
2. **Wire** on
3. **Working** on
4. **Start**
5. Also check to be sure **A-CON-TROL** light is on.



Unclamped Clamped

Figure 6.

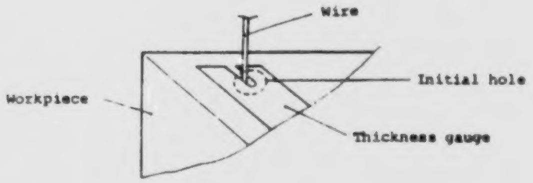


Figure 7.

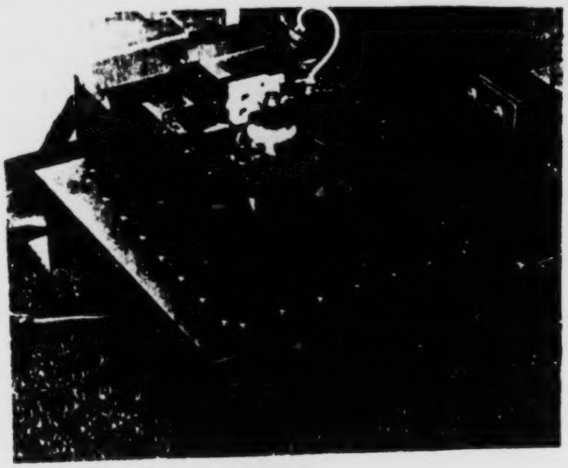
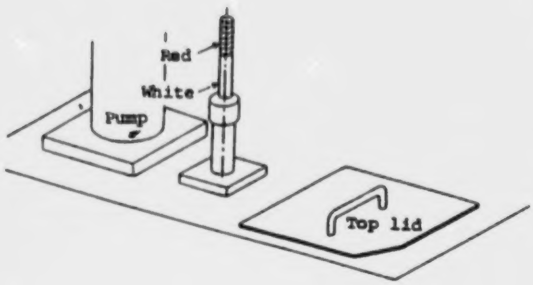


Figure 8.

BEST COPY AVAILABLE

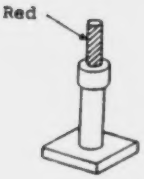
Dielectric fluid replenishment



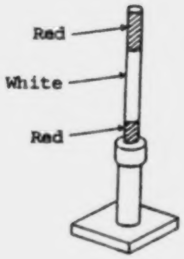
Dielectric fluid decreases gradually by vaporization during operation because it continuously circulates between the machine and dielectric fluid reservoir. Replenish dielectric fluid, therefore, once every few days before the detecting rod of the level gauge on the tank reaches the red position. Make sure the rod is in the white area during machining.

Remove the top lid and replenish dielectric fluid in the tank to the upper part of the level gauge that is mounted on the inside surface of the tank. Be sure to replenish dielectric fluid after filter element replacement because that procedure drains a large volume of dielectric fluid.

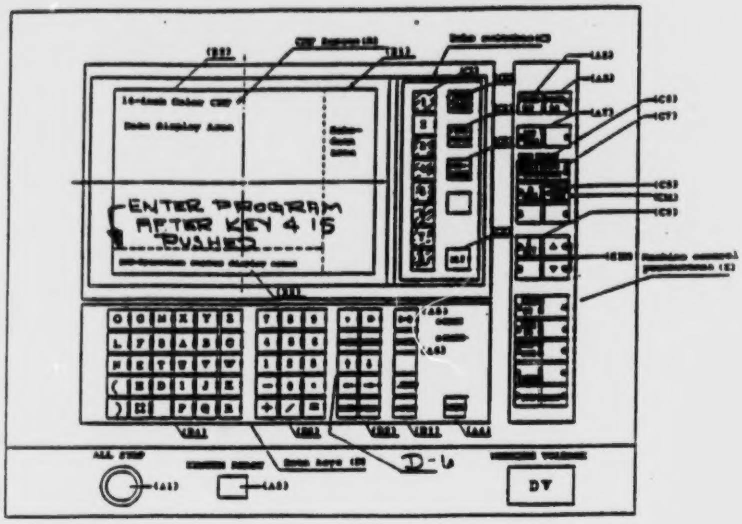
Adjust the fluid level so that it is positioned in the white area of the dirty fluid tank level gauge in ordinary operation.



Too little fluid. Supply tap water in the dirty fluid tank until the white area appears.



Too much fluid. Drain machining fluid from the dirty fluid tank until the lower red area is invisible.


14-inch Color CRT
Data Display Area
ENTER PROGRAM AFTER KEY 4 IS PUSHED
ALL STOP
(A1)
(A3)
Data keys (B)
D-6
DV

21 You are now ready to pull up the graphs on the machine. To do this the following steps should be taken, push the following buttons.

1. **DISPLAY**

2. (6) **GRAPHICS**

3. (1) **POSITON**

4. (4) **PROGRAM**

   A. Enter part number where cursor is flashing - lower left. **Note!** you may need to push Delete button if number or part of old number remains.

   B. **INPUT** button.

5. (3) **TRACE**

6. (5) **VIEWPOINT**

   A. **#1** on keyboard

7. (7) **FRAME**

   A. * key

8. Wait until Auto scaling fin appears (lower right of CRT).

9. (8) **DRAWING START**

Note! If you go out of the graphics screen and you want to get back to it just push **DISPLAY and (6)**. You have now completely set up the part but don't forget to change the E PACK number once you are into the cut approximately 1/8 inch.

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Notes:

Unit 23

Introduction

A program will be developed on the Medi-apt computer using points, lines, and circles.

Objectives

Upon successful completion of this lesson, the trainee will be able to:

1. Identify various methods of programming circles.
2. Apply few methods of programmming circles.
3. Apply motion direction and position of a circle.
4. Program a part using points, lines, and circles.
5. Check the programmed part for any error.
6. Send program to machine.

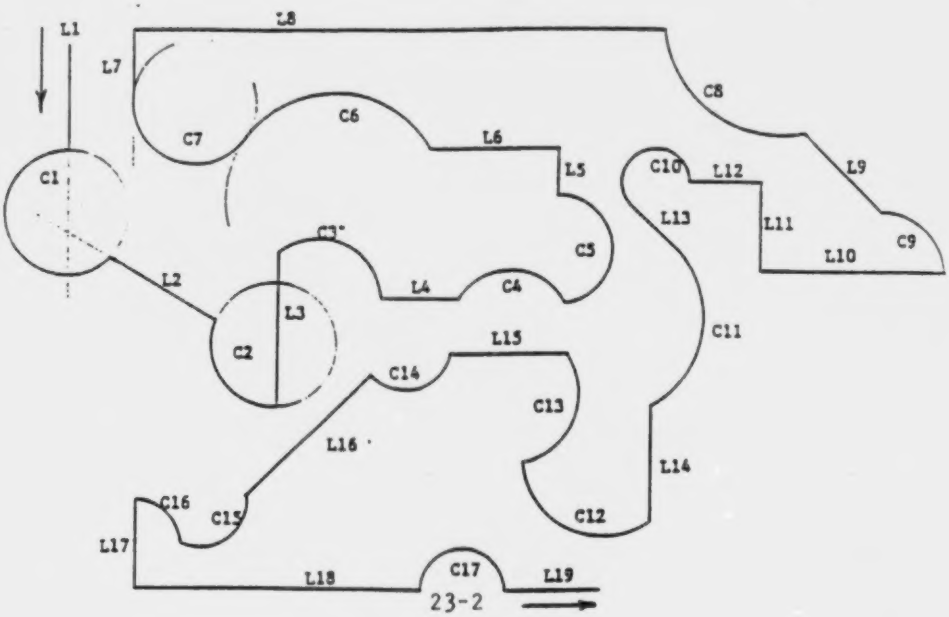
MOTION PRACTICE EXAMPLE

When using the Medi-apt to describe movement around the object the following method is used to describe the moves for line to circles and circles to line. The abbreviation for the Medi-apt would be as follows:

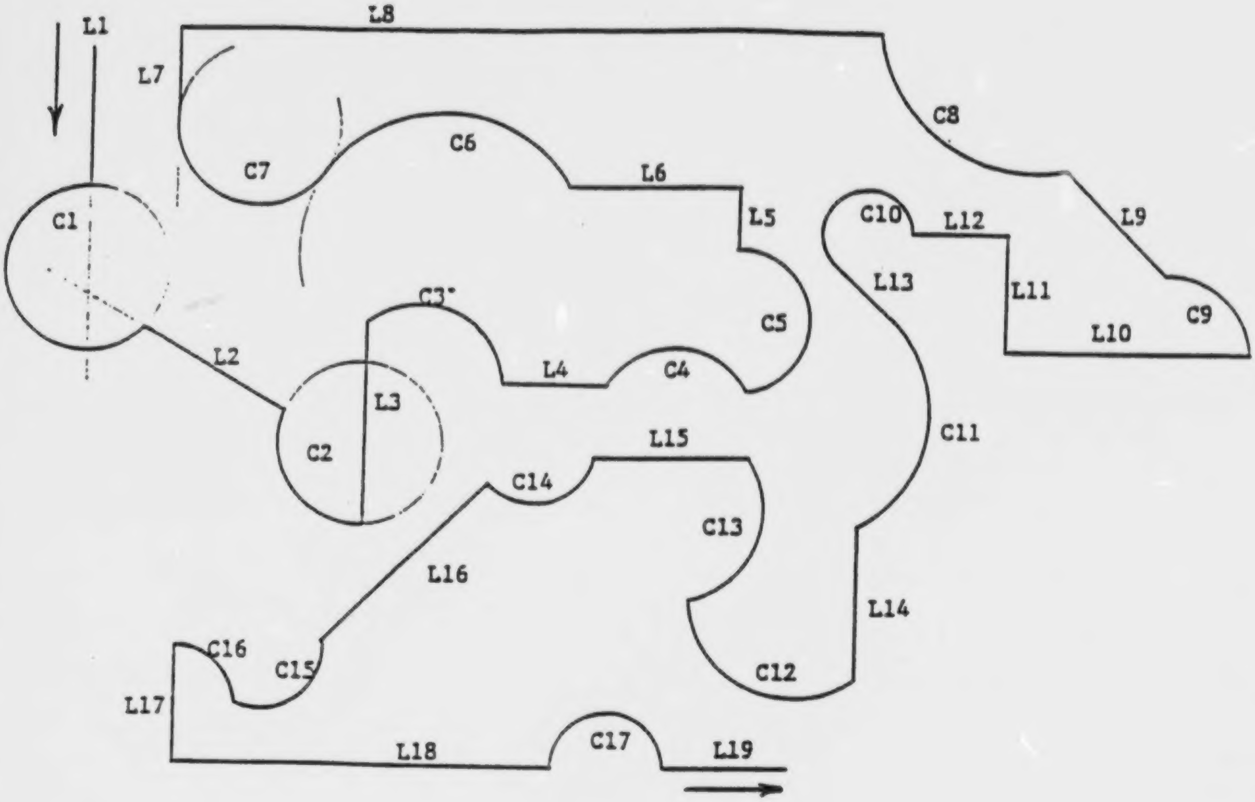
L1	Line 1	L	Left
C1	Circle 1	R	Right
U	Up	CC	Counter Clockwise
D	Down	CW	Clockwise

Starting with L1 the first 8 moves would be as shown below, C1 describes the circle. CC means it is to move counter clockwise and U would mean up on the circle or at the top of the circle or at the top of the circle. Next you move to line 2, L2 - line 2 and R right side of circle (this could also be D for down depending how the Mediapt looks at it). Next you move to C2, C2 - circle 2, CC counter clockwise, L, left of circle. The next four moves are described below. Study them over and go finish all of the other moves. If you have any problems, see your instructor.

1. L1
2. C1,CC,U
3. L2,R
4. C2,CC,L
5. L3,D
6. C3,CW,U
7. L4,R
8. C4,CW,L


L1
L8
L7
C8
C7
C6
L6
L5
C10
L12
L9
C1
L13
L11
C3
C5
C9
L10
L2
L4
C4
L3
C11
C2
L15
C14
C13
L16
L14
C16
C15
C12
L17
L18
C17
L19

MOTION PRACTICE

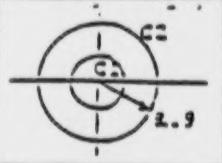
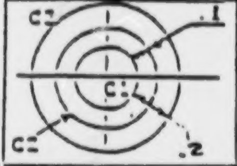
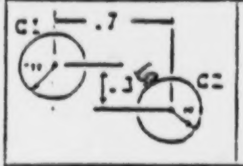
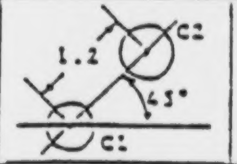
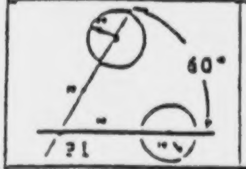
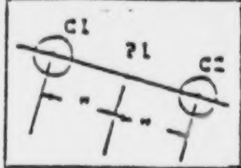
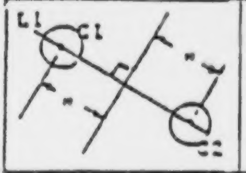
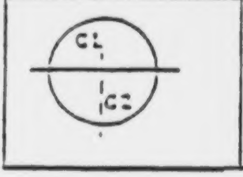

L1
L8
L7
C8
C7
C6
L6
L5
C10
L12
L9
C1
L13
L11
L10
C9
C3
C5
L2
L4
C4
L3
C2
L15
C11
C14
C13
L16
L14
C16
C15
L17
C12
C17
L18
L19

9. __________
10. __________
11. __________
12. __________
13. __________
14. __________
15. __________
16. __________
17. __________
18. __________

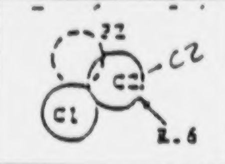
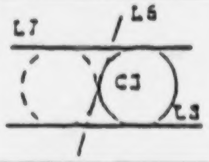
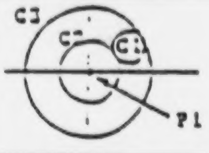
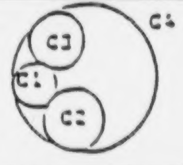
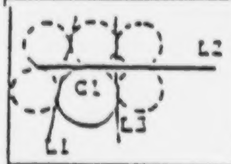
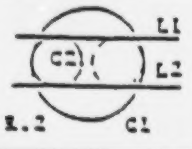
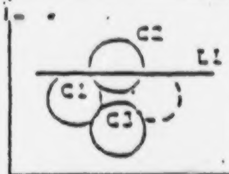
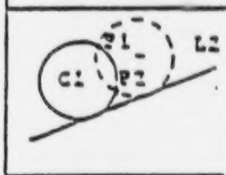
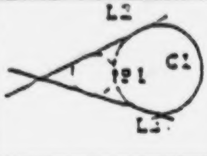
19. __________
20. __________
21. __________
22. __________
23. __________
24. __________
25. __________
26. __________
27. __________

28. __________
29. __________
30. __________
31. __________
32. __________
33. __________
34. __________
35. __________
36. __________

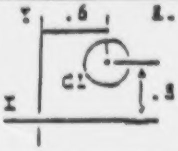
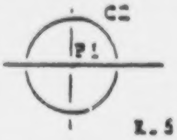
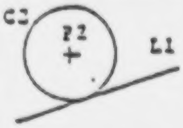
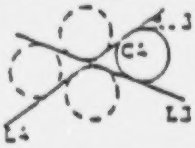
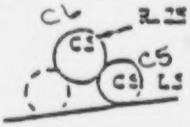
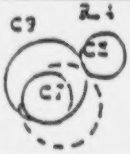
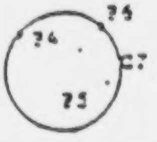
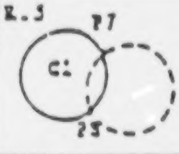
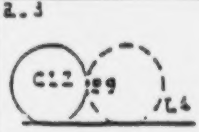
CIRCLE DEFINITIONS

	C2:C1/R9	Circle with the same center point as another circle with a given radius
	C2:C1,0/D2	Concentric circle smaller or larger than existing circle
	C2:C1/X.7/Y-.5	Circle with XY coordinates from existing circle with same radius
	C2:C1/R1.2/A45	Polar coordinates from existing with angle from X axis
	C2:c1/P1/A60	Circle defined with reference from a point with angle from another circle
	C2:C1/P1	Symetrical circle with relation to a point
	C2:C1/L1	Symetrical circle with relation to a line
	C2=C1	Circle re-defined as another circle

CIRCLE DEFINITIONS

 P2 C2 C2 C1 R.6	C1:P2/C1,O,R/R6	Circle through a point tangent to another circle with a given radius
	C3:L7/L3/L6,R two parallel lines	Circle tangent to two parallel lines & another line
	C2:P1/C1,S C3:P1/C1,B	Circle with given center point & tangent to another circle
	C1:C2,O/C4,I/C3,O,L	Circle tangent to three circles
	C1:L1,R/L2,D/L3,L	Circle tangent to three lines
 L1 C2 L2 R.2 C1	C2:L1,D/L2,U/C1,I,L/R2	Circle tangent to two lines & a circle
	C1:L1,D/C3,O/C2,O,L	Circle tangent to a line & two circles
	C1:P1/P2/L2,L	Circle through two points & tangent to a line
	C1:P1/L2/L3,R	Circle through a point & tangent to two lines

CIRCLE DEFINITIONS

	C1:X6/Y.3/R4	Circle with given center coordinates & radius
	C2:P1/R4	Circle with given center point & radius
	C3:P2/L1	Given center point tangent to a line
	C4:L3,U/L4,R/R.3	Circle tangent to two lines with a given radius
 C6 R.25 C5 C5 L5	C6:L5,U/C5,O,R/R.25	Circle tangent to a line & a circle with a given radius
	C9,C7,I/C3,O,U/R4	Circle tangent to two circles with a given radius
	C7:P4/P6/P5	Circle through three points
	C1:P7/P3/R5	Circle through two points with a given radius
	C12:P9/L4,L/R3	Circle through a point & tangent to a line with a given radius

PROGRAMMING CIRCLES AND USING THE MINIMUM RADIUS

In the example on the previous page, we will be programming circles and using the (MINR) feature on the Medi-apt.

Note! It is not necessary to enter the 3 zeros when typing in the points, lines, and circles (example: (P0001) P1 is all that is necessary). The computer will put in the "0" when you request a list.

In the example shown on the previous page at 0060 and 0090, you will notice a circle is described as C1 or C2 being equal to the X coordinate/ the Y coordinate/ and an R or radius. Also note the way the circle is described and listed in the sequence of operations from 0130 to 0270.

You will notice at 0170 C1,CW,U

C1 is circle 1

CW is clockwise

U is up (for the top of the circle)

Also look at 0180 L3,D the D means down and the circle

The next circle is circle 2 (0230)

C2 circle 2

CC counter clockwise

D is down (bottom of circle)

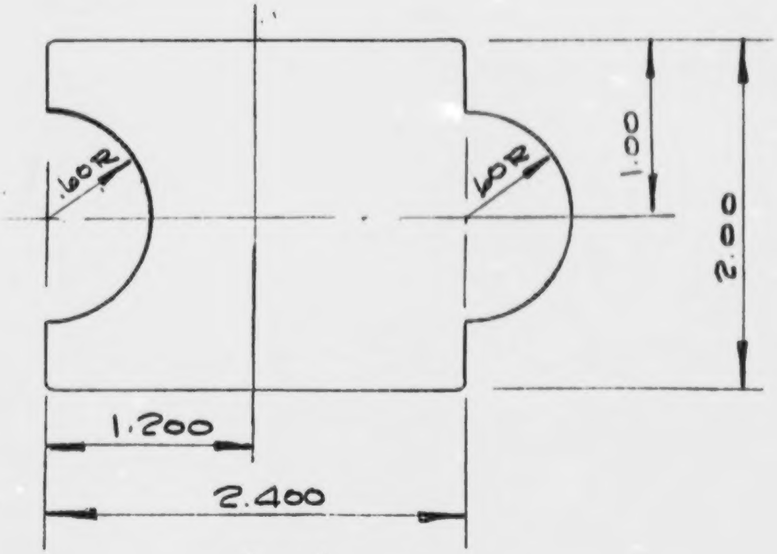
On 0240 you have L5, U for up on the circle

Also notice the MINR/.050 at 0100 this means a minimum radius of .050, where ever you enter an "R" in the list of moves you will have a minimum radius of .050 (at 0150, 0190, 0210, 0250). You will also notice on the drawing that there is a .050 in each one of these corners.

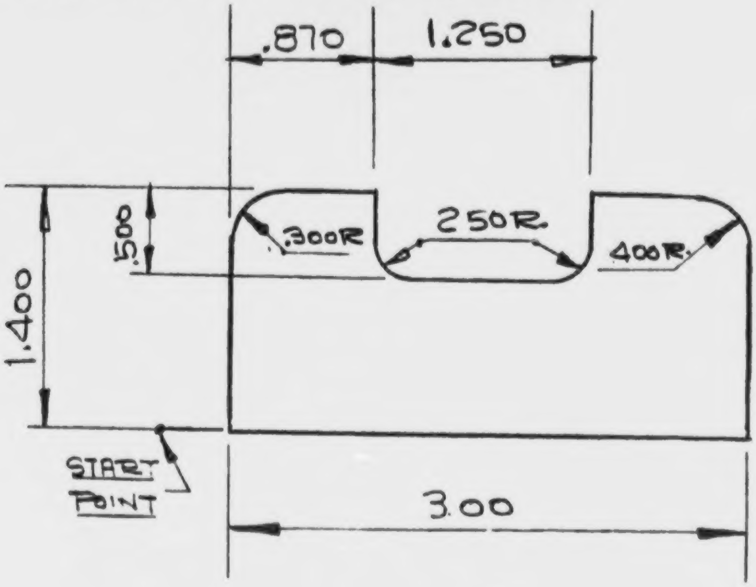
PROGRAMMING POINTS, LINES, AND CIRCLES

Program the part shown below using basic points, lines, and circles. See the following page for description of circles.

```
0010        P0001   = X    1.2000 /Y    2.2000
0020        L0001   = X    1.2000
0030        P0002   = X    1.2000 /Y    2.0000
0040        L0002   = Y    2.0000
0050        L0003   = X    2.4000
0060        C0001   = X    2.4000 /Y    1.0000    /R    0.6000
0070        L0004   = Y    0.0000
0080        L0005   = X    0.0000
0090        C0002   = X    0.0000 /Y    1.0000    /R    0.6000
0100        MINR /.050
0110        SET  /P1,L
0120        INST /F500M90 ;
0130        L0001
0140        L0002
0150        R0.0000
0160        L0003
0170        C0001,CW,U
0180        L0003,D
0190        R0.0000
0200        L0004
0210        R0.0000
0220        L0005
0230        C0002,CC,D
0240        L0005,U
0250        R0.0000
0260        L0002
0270        P0002
0280        STOP
0290        INST /G40F5000M91 ;
0300        END
0310        MEND
```



Program the part shown below on the Mediapt. Check for any errors and correct any of the errors. Send program to machine and go to machine and plot the part to see if there are any errors.



.870
1.250
.300R
250R
400R
.500
1.400
START POINT
3.00

Notes:

Unit 24

Introduction

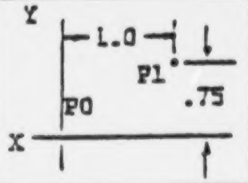
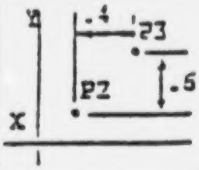
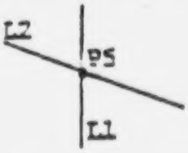
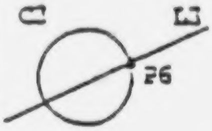
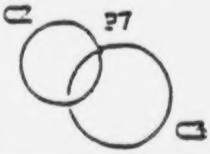
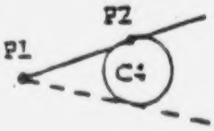
A program will be written using the various methods of describing lines off of circles and points.

Objectives

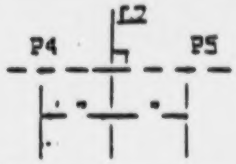
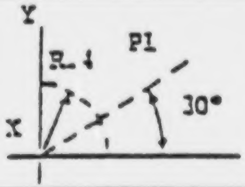
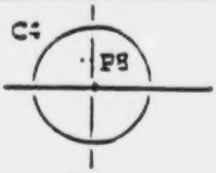
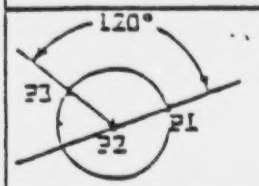
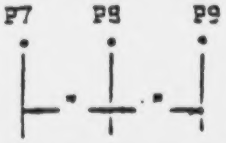
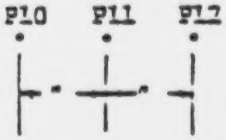
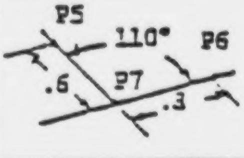
Upon succesful completion of this lesson the trainee will be able to:

1. Program lines tangent to circles.
2. Program angle lines from points.
3. Program angle lines from points on circles.
4. Identify points on intersection of circles.
5. Program angle lines center of circle.

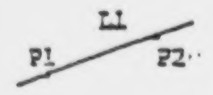
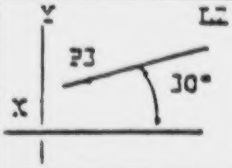
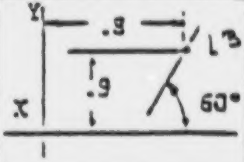
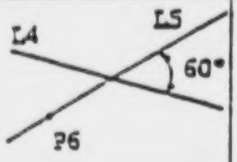
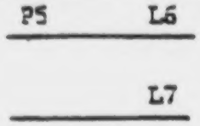
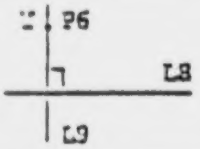
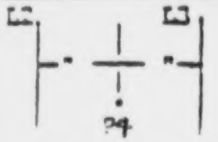
POINT DEFINITIONS

 Y L.0 P1 P0 .75 X	P1:X1/Y.75	Point with XY coordinates from P0
	P3:P2/X.4/Y.5	Point with XY coordinates from another point
	P5:L1/L2	Intersection of two lines
	P6:L3/C3,R	Intersection of a line & a circle
	P7:C2/C3,U	Intersection of two circles
	P2:P1/C4,U	Tangent point from a point to a circle

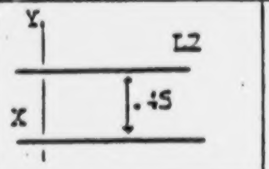
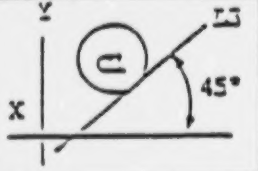
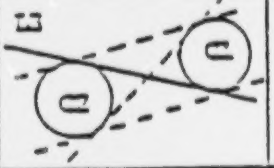
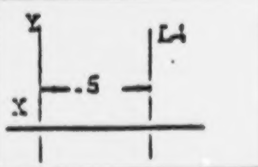
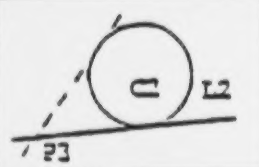
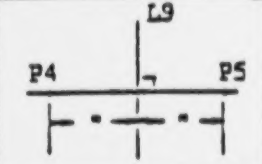
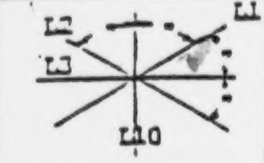
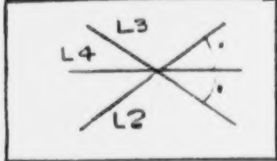
POINT DEFINITIONS

	PS:Pr/L2	Symetrical points
	P1:P0/R.4/A30	Polar cordinate from another point with an angle from the X axis
	P8:C4	The center point of a circle
	P3:P1/P2/A120 center point	Point with a nucleus (P2) with angle from P1
	P7:P9/P8 center point	Symetrical point with equal distance from center point
	P11:P10/P12,N	Point defined exactly between two existing points
 P5 110° P6 .6 P7 .3	P5:P6/P7/A110/D.6	Point with demensions from P7 and angle given from P6

LINE DEFINITIONS

	L1:P1/P2	Line passing through two points
	L2:P3/A30	Line through a point with an angle given from X axis
	L3:X.8/Y.9/A60	Line through XY coordinates with an angle given from the X axis
	L5:P6/L4/A+60	Line through a point with an angle given from another line
	L6:P5/L7,P5	Line through a point parallel to another line
	L9:P6/L8,N	Line through a point & perpendicular (N) another line
	L2:L3/P4	Symetrical lines with dimensions given from

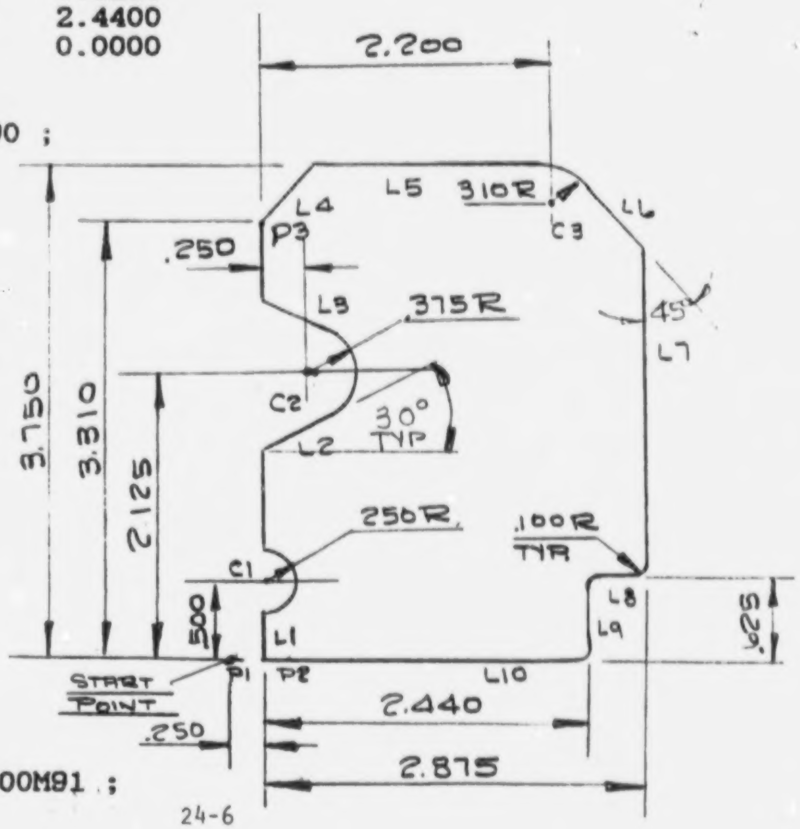
LINE DEFINITIONS

	L2:LX,U/D,45	Line parallel to another line with given distance
	L3:C1,D/A45	Line tangent to a circle with an angle given from X axis
	L3:C2,U/C1,D	Line tangent to two circles
	L4:X.6	Line parallel to X or Y axis with a given distance
	L2:P3/C2,D	Line through a point tangent to a circle
	L9:P4/P5, N	Line between two points perpendicular (N) to a line thru two point
	L10:L1,U/L2,U L3:L1,D/L2U	Line difined equally between two lines with a given direction
	L3:L2/L4	Line defined symetrical from two existing lines

PROGRAMMING LINES TANGENT TO CIRCLES AND LINES OFF OF POINTS

There are many ways to program points, lines, and circles on the Medi-apt. In a previous chapter circles were programmed by various methods. In this chapter, we will identify methods of programming points and lines. A few examples of lines tangent to circles and lines connecting with points are used in the program below. See following page on explanation of program shown below.

```
0010        P0001    = X    -0.2500 /Y     0.0000
0020        P0002    = X     0.0000 /Y     0.0000
0030        L0001    = X     0.0000
0040        C0001    = X     0.0000 /Y     0.5000     /R     0.2500
0050        C0002    = X     0.2500 /Y     2.1250     /R     0.3750
0060        L0002    = C0002     ,D /A    30.0000
0070        L0003    = C0002     ,U /A   150.0000
0080        P0003    = X     0.0000 /Y     3.3100
0090        L0004    = P0003        /A    45.0000
0100        L0005    = Y     3.7500
0110        C0003    = X     2.2000 /Y     3.4400     /R     0.3100
0120        L0006    = C0003     ,R /A   135.0000
0130        L0007    = X     2.8750
0140        L0008    = Y     0.6250
0150        L0009    = X     2.4400
0160        L0010    = Y     0.0000
0170        MINR /.100
0180        SET  /P1,L
0190        INST /F500M90 ;
0200        P0002
0210        L0001
0220        C0001,CC,D
0230        L0001,U
0240        L0002
0250        C0002,CC
0260        L0003,U
0270        L0001
0280        L0004
0290        L0005
0300        C0003,CW
0310        L0006,R
0320        L0007
0330        R0.0000
0340        L0008
0350        R0.0000
0360        L0009
0370        R0.0000
0380        L0010
0390        P0002
0400        STOP
0410        INST /G40F5000M91 ;
0420        P0001
0430        END
0440        MEND
```



As you read through the program, you will notice 0040, 0050, and 0110 describe circles 1, 2, and 3. Lines 2, 3, and 6 (at 0060, 0070, and 0120) describe the line working from the circle at a given angle. Remember the angle is always started at 3 o'clock. Note also, how the lines and cirles are at 0220, 0230, 0250, 0260, 0300, and 0310. The .100 radii are given in the min radius description.

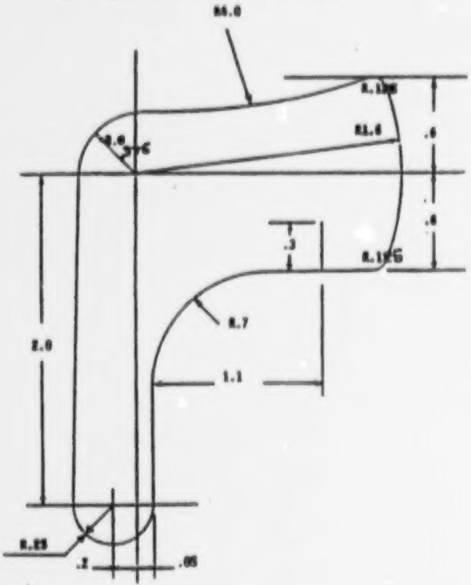
```
0040 C1:X0/Y500/R.250
0050 C2:X.250Y2.125/R.375
0110 C3:X2.20/3.44/R.310

0060 L2:C2,D/A30
0070 L3:C2U/A150
0120 L6:C3,R/A135

0220 C1,CC,D
0230 L1,U
0250 C2,CC
0260 L3,U
0300 C3,CW
0310 L6,R
```

This part is programmed using various circle descriptions as shown below.

```
0010        P0001   = X    1.1500 /Y   -0.3000
0020        P0002   = X    1.1500 /Y   -0.6000
0030        P0002   = X    1.1000 /Y   -0.6000
0040        L0001   = Y   -0.6000
0050        L0002   = X    0.0500
0060        C0001   = L0001    ,D /L0002    ,R    /R    0.7000
0070        C0002   = X   -0.2000 /Y   -2.0000    /R    0.2500
0080        C0003   = P0000       /R    0.4000
0090        L0003   = C0002    ,L /C0003    ,L
0100        C0005   = P0000       /R    1.6000
0110        L0004   = Y    0.6000
0120        C0006   = L0004    ,D /C0005    ,R ,I /R    0.1000
0130        C0006,CW
0140        C0004   = C0003    ,D /C0006    ,U ,D /R    4.0000
0150        MINR /.1
0160        SET  /P1,L
0170        INST /F500M90 ;
0180        P0002
0190        L0001
0200        C0001,CC
0210        L0002
0220        C0002,CW
0230        L0003
0240        C0003,CW
0250        C0004,CC
0260        C0006,CW
0270        C0005,CW
0280        R0.0000
0290        L0001,R
0300        P0002
0310        STOP
0320        INST /G40F5000M91 ;
0330        END
0340        MEND
     $
```



Moves 0010 to 0050 are basic moves starting with:

0060 C1-L1,D/L2,R/R.7

The circle is down from line one, to the right of line 2 and has a .7 radius.

<u>0080</u> C3=P0/R.400

The circle is at X0Y0 and has a .400R

0090 L3=C2,L/C3,L

Line 3 is a tangent to circle 2 on left and also circle 3 on left.

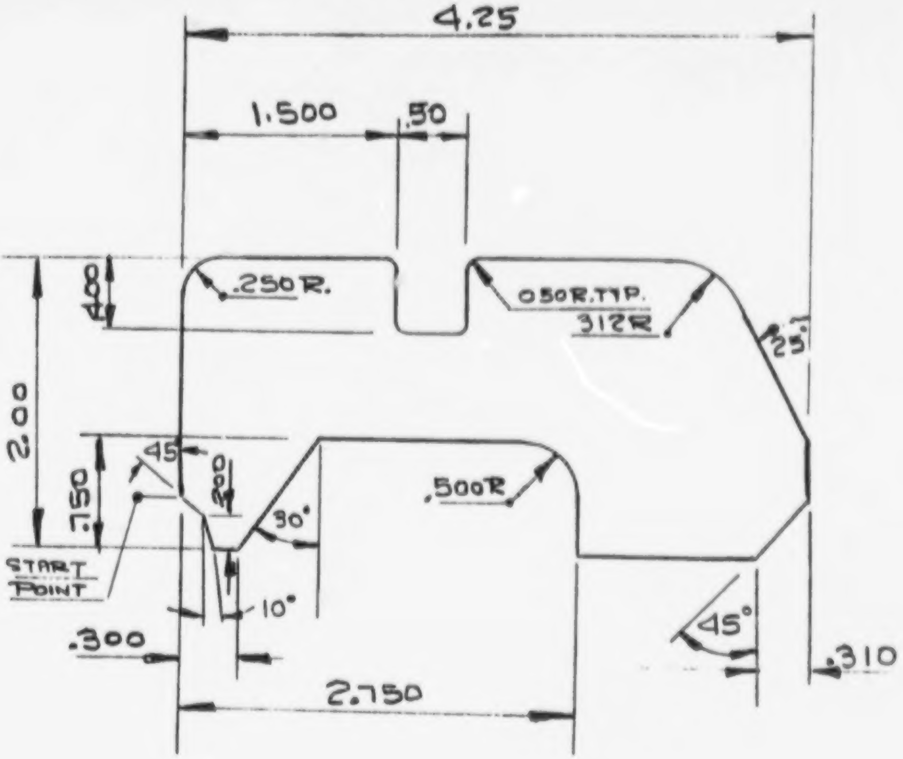
0120 C6=L4,D/C5,U,I/R.100

Circle 6 tangent to line 4 down, tangent to circle 5 up and on the inside, and has a .100 radius.

0140 C4=C3,O/C6,U,O/R4.00

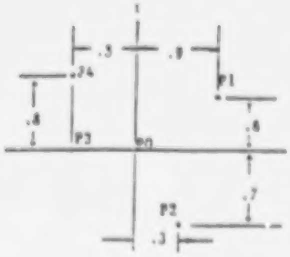
C4 is tangent to C3 on the outside, tangent to C6 up and outside and has a 4.00 radius.

Program the part shown below on the Mediapt. Check for any errors and correct any of the errors. Send program to machine and go to machine and plot the part to see if there are any errors.


4.25
1.500
.50
.250R.
.050R.TYP.
.312R
25°
.400
2.00
.750
45
.300
30°
.500R
START POINT
10°
.300
2.750
45°
.310

MEDIAPT DEFINITION'S (EXERCISE)

POINTS, LINES, CIRCLES



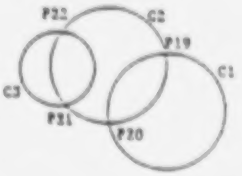
.3
.9
.24
P1
.8
.6
P3
P0
.7
P2
.3

P1:

P2:

P3:

P4:



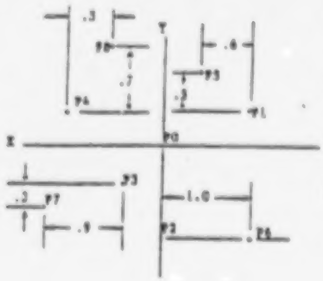
P22
C2
P19
C1
C3
P21
P20

P19:

P20:

P21:

P22:



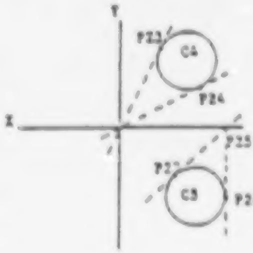
.3
Y
.4
P8
P5
.7
.3
P6
P1
X
P0
P3
.3
P7
.9
1.0
P2
P4

P5:

P6:

P7:

P8:



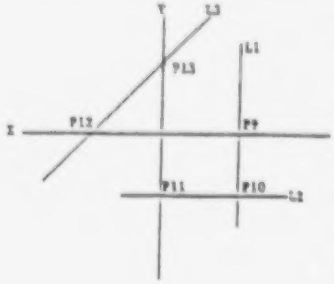
Y
P23
C4
P24
X
P25
P27
C5
P26

P23:

P24:

P26:

P27:



Y
L3
L1
P13
X
P12
P9
P11
P10
L2

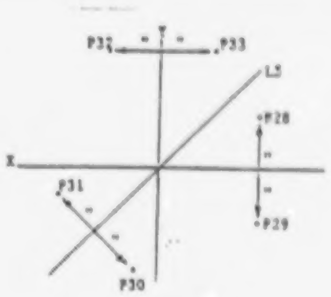
P9:

P10:

P11:

P12:

P13:

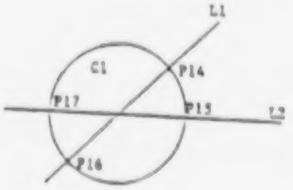


P32
Y
P33
L5
P28
X
P31
P29
P30

P29:

P31:

P33:



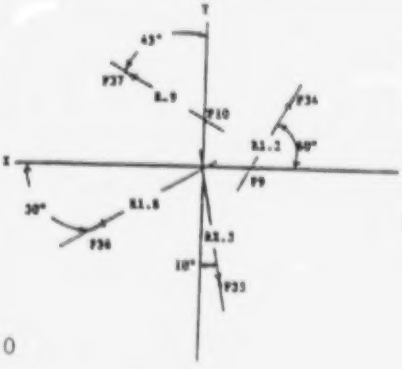
L1
C1
P14
P17
P15
L2
P16

P14:

P15:

P16:

P17:



Y
45°
P37
R.9
P10
P34
R1.2
60°
X
P9
30°
R1.8
P36
R2.3
10°
P35

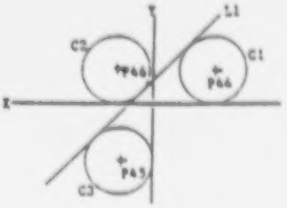
P34:

P35:

P36:

P37:

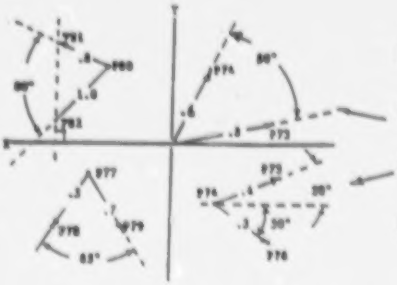
MEDIAPT DEFINITIONS (EXERCISE)
POINTS, LINES, CIRCLES


Y
L1
C2
P46
C1
P44
X
P45
C3

P44:

P45:

P46:

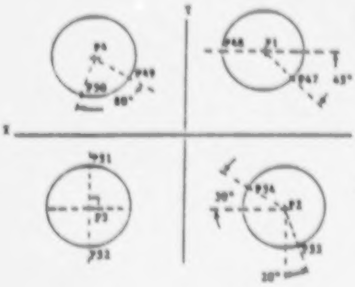

P81
.8
P80
60°
1.0
P82
P74
.6
60°
.8
P73
P77
.3
P78
P79
45°
P75
P74
.4
30°
.3
30°
P76

P74:

P76:

P79:

P82:

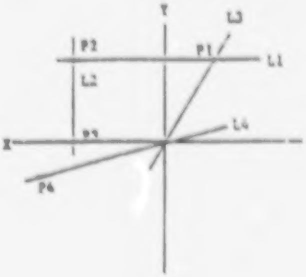

Y
P5
P49
P50
60°
P48
P1
P47
45°
X
P51
P3
P52
30°
P54
P2
P53
30°

P48:

P50:

P52:

P54:

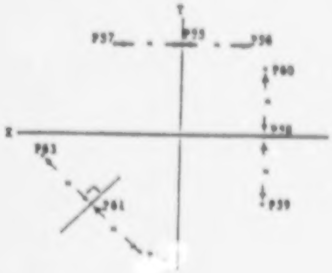

Y
L3
P2
P1
L1
L2
L4
X
P3
P4

L1:

L2:

L3:

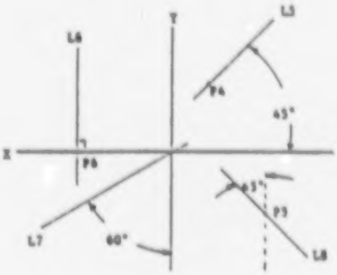
L4:


Y
P57
P55
P56
P60
X
P58
P63
P61
P59

P57:

P60:

P63:

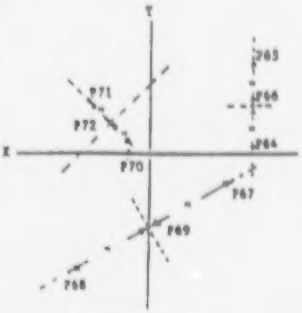

L3
L6
Y
P4
45°
X
P6
45°
P5
L7
60°
L8

L5:

L6:

L7:

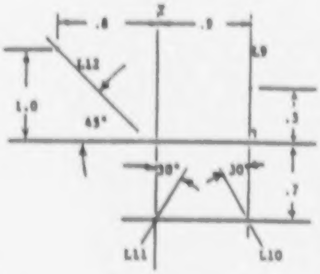
L8:


Y
P65
P71
P66
P72
X
P64
P70
P67
P69
P68

P66:

P69:

P72:


.8
Y
.9
L9
L12
1.0
45°
.3
30°
30°
.7
L11
L10

L9:

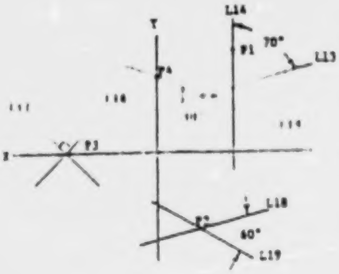
L10:

L11:

L12:

MEDIAPT DEFINITIONS (EXERCISE)

POINTS, LINES, CIRCLES



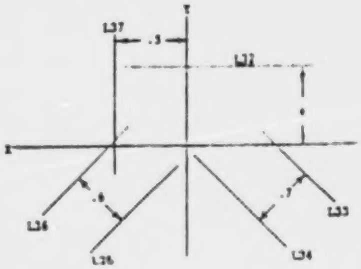
L14
Y
70°
P1
L13
P3
X
L18
60°
L19

L14:

[illegible]

L17:

L19:



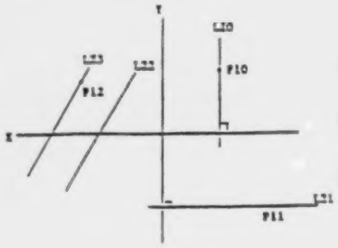
Y
L37
.3
L32
X
.6
.7
L36
L33
L35
L34

L32:

[illegible]

L36:

L37:

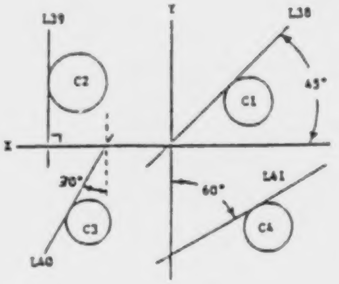


Y
L20
L23
L22
P10
P12
X
L21
P11

L20:

L21:

L23:



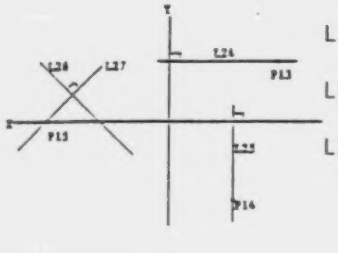
L39
Y
L38
C2
C1
45°
X
30°
60°
L41
C3
C4
L40

L38:

L39:

L40:

L41:

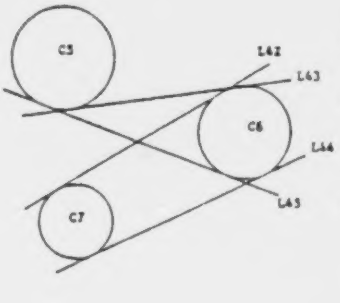


Y
L26
L27
L24
P13
X
P15
L25
P14

L24:

L25:

L27:



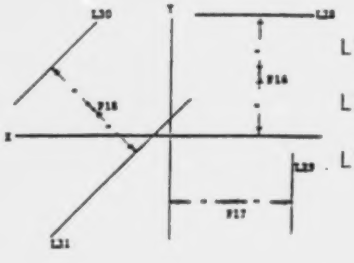
C5
L42
L43
C6
L44
L45
C7

L42:

L43:

L44:

L45:

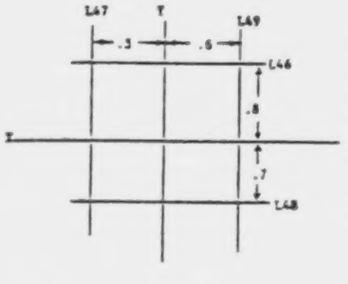


L30
Y
L28
P16
P18
X
L29
P17
L31

L28:

L29:

L31:



L47
Y
L49
.3
.6
L46
.8
Y
.7
L48

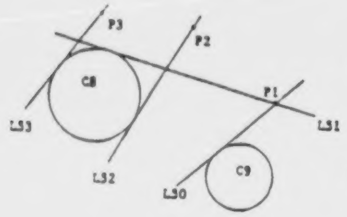
L46:

L47:

L48:

L49:

MEDIAPT DEFINITIONS (EXERCISE)
POINTS, LINES, CIRCLES

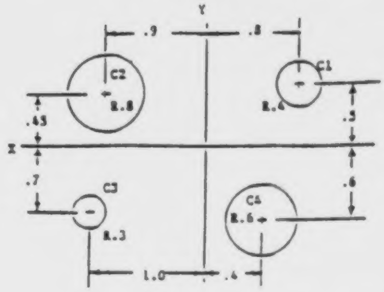

P3
P2
C8
P1
L53
L51
L32
L30
C9

L50:

L51:

L52:

L53:

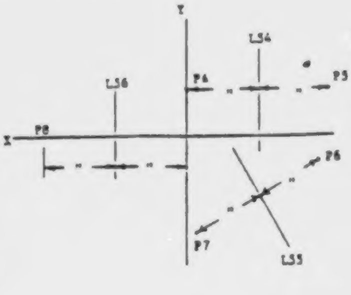

Y
.9
.8
C2
C1
R.8
R.4
.45
.5
X
.7
.6
C3
C4
R.6
R.3
1.0
.4

C1:

C2:

C3:

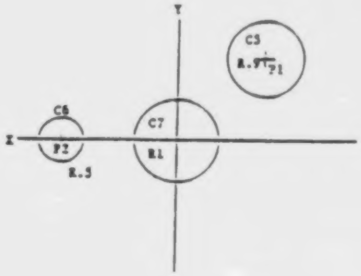
C4:


Y
L54
L56
P4
P5
X
P8
P6
P7
L55

L54:

L55:

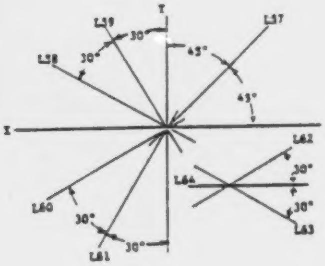
L56:


Y
C5
R.9
P1
C6
C7
X
P2
R1
R.5

C5:

C6:

C7:

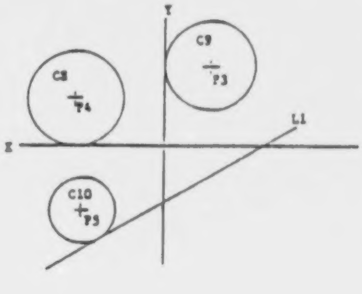

L59
Y
L57
30°
L58
30°
45°
45°
X
L62
30°
L64
30°
L60
L63
30°
L61
30°

L57:

L59:

L61:

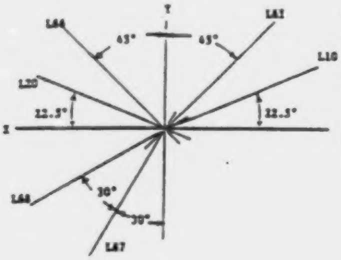
L64:


Y
C9
P3
C8
P4
L1
X
C10
P5

C8:

C9:

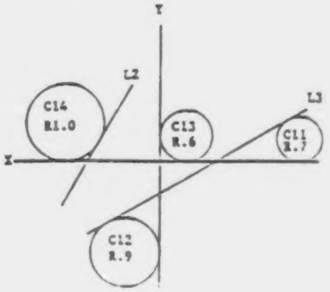
C10:


Y
L66
45°
45°
L65
L10
L20
22.5°
22.5°
X
L68
30°
30°
L67

L65:

L66:

L68:


Y
L2
L3
C14
R1.0
C13
R.6
C11
R.7
X
C12
R.9

C11:

C12:

C13:

C14:

Notes:

Unit 25

Introduction

A piecepart will be manually programmed, entered into the machine and edited. Programs that were written on the computer will be edited at the machine.

Objectives

Upon successful completion of this lesson the trainee will be able to:

1. Identify G codes used on the wire EDM.
2. Identify M codes used on the wire EDM
3. Understand arcs and how they are defined.
4. Manually program a part on the machine.
5. Edit a program on the machine.
6. Transfer a program into the memory of the machine.

FUNCTION M

M Commands may be given from tape or by manual data input. They can be given singly or concurrently in the same block with other commands. If specified concurrently with other commands, M00, M01, M02, M30, and M93 are executed after other commands have been completed. When there are two or more M commands in the same block, they are executed in the order of input. If four or more M commands are specified, the last three become effective.

M code	Name	Function
M00	Program stop	Stops automatic operation
M01	Optional stop	Same as above, effective only when optional switch is ON.
M02	Program end	Terminates automatic operation and resets.
M03	Electrode rotation ON	Rotates an electorde for an initial hole
M05	Electrode rotation Off	Stops an electrode rotating for an initial hole
M20	Wire insert	Inserts a wire by automatic wire feeder
M21	Wire cut	Cut off a wire by automatic wire feeder
M22	Test Insert	Lowers and raises tube quide by automatic wire feeder
M23	Fixed position return	Reset tube quide in fixed position by automatic wire feeder
M24	AEC wire 1 set	Sets wire electrode (1).
M25	AEC wire 2 set	Sets wire electrode (2).
M27	B-axis rotation (+)	Turns B-axis in + direction
M28	B-axis rotation (-)	Turns B-axis in - direction

FUNCTION M

M code	Name	Function
M29	B-axis rotation OFF	Turns OFF B-axis rotation
M30	Program and	Terminates automatic operation, rewinds, and resets.
M38	B-axis low speed rotation	Turns B-axis at low speed.
M39	B-axis high speed rotation	Turns B-axis at high speed
M46	Initial hole compensation 1	Die machining, reverse move for compensation
M47	Initial hole compensation 2	Die machining, move for compensation (load compensation at compensation plot)
M48	Initial hole compensation 3	Punch machining, move for compensation
M49	Initial hole compensation 4	Punch machining, load compensation plot
M52	Scrap handling ON	Performs automatic scrap handling
M58	Fluid level setting-	Holds fluid level below the worktable
M59	Fluid level setting-High	Hold fluid level above the " worktable
M60	External signal output 1 ON	Turns ON controller external output terminal 1.
M61	External signal output 1 OFF	Turns OFF " "
M62	External signal output 2 ON	Turns ON controller external output terminal 2.
M63	External signal output 2 OFF	Turns OFF " "
M64	External signal output 3 ON	Turns ON controller external output terminal 3.
M65	External signal output 3 OFF	Turns OFF " "
M66	External signal output 4 ON	Turns ON controller external output terminal 4.
M67	External signal output 4 OFF	Turns OFF " "

FUNCTION M

M code	Name	Function
M68	External signal output 5 ON	Turns ON controller external output terminal 5.
M69	External signal output 5 OFF	Turns OFF " "
M70	Initial hole mode ON	Initial hole mode ON
M71	Initial hole mode OFF	Initial hole mode OFF
M72	Touch sensor mode ON	Enables position measuring by touch sensor
M73	Touch sensor made OFF	Turns OFF position measuring mode by touch sensor
M74	Dielectric fluid preparation ON	Dielectric fluid preparation ON
M75	Dielectric fluid preparation OFF	Dielectric fluid preparation OFF
M76	Dielectric fluid circulation ON	Dielectric fluid circulation ON
M77	Dielectric fluid circulation OFF	Dielectric fluid circulation OFF
M78	Rapid filling up	Fills up fluid rapidly
M80	Dielectric fluid ON	Feeds fielectric fluid
M81	Dielectric fluid OFF	Stops dielectric fluid
M82	Wire feed ON	Starts wire feed
M83	Wire feed OFF	Stops wire feed
M84	Machining ON	Turns ON the power supply
M85	Machining OFF	Turns OFF the power supply
M88	Dielectric fluid Weak	Decreases fluid flow
M89	Dielectric fluid Full	Increases fluid flow
M90	Starts adaptive control	Adaptive feed ON
M91	Adaptive feed OFF	Stops Adaptive control
M93	All stop	Turns Off SYSTEM READY switch

FUNCTION G

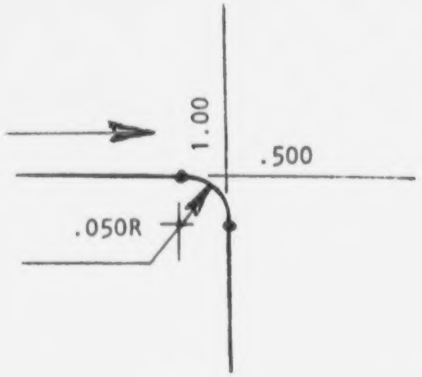
G code	Group	Function
G00	A	Positioning
G01	A*	Linear interpolation
G02	A	Circular interpolation CW/Helical interpolation CW/R designation circular interporation CW
G03	A	Circular interpolation CCW/Helical interpolation CCW/R designation circular interpolation CCW
G04	*1	Dwell
G14	*1	Current position reading
G22	D	Subprogram call/Figure rotation/User macro
G23	D	Subprogram return/Figure rotation/User macro
G27	*1	Zero point collation
G28	*1	Automatic zero point return (memory type)
G29	*1	Automatic edge positioning
G30	*1	Automatic center positioning
G40	E*	Wire diameter compensation cancel/taper angle cancel
G41	E	Wire diameter compensation (left)
G42	E	Wire diameter compensation (right)
G43	*1	Program wire diameter compensation distance setting/work coordinate offset setting
G44	*1	Program wire diameter compensation distance transfer
G46	*3	Microjoint function
G48	*1	Memory-type automatic zero point (2nd, 3rd, and 4th) reference point return
G52	*2	Local coordinate setting
G53	F	Machine coordinate select
G54	F*	G54 work coordinate select
G55	F	G55 work coordinate select
G56	F	G56 work coordinate select
G57	F	G57 work coordinate select

FUNCTION G

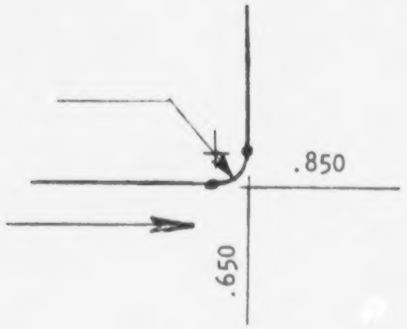
G code	Group	Function
G58	F	G58 work coordinate select
G59	F	G59 work coordinate select
G60	*1	Dog-type zero point return
G62	*1	G command mirror image
G69	*3	Circular end point error check cancellation
G70	G	Inch command
G71	G*	Metric command
G87	*B	Upper lower idential R
G88	B	Corner R mode
G89	B*	Intersection point calculation mode
G90	H	Absolute value command
G91	H*	Increment command
G92	*2	Zero point preset
G97	*1	X-Y axis exchange
G101	J	$a = b$
G102	J	$a = b+c$
G103	J	$a = b-c$
G104	J	$a = b*c$
G105	J	$a = b/c$
G106	J	$a = \sqrt{b^2+c^2}$
G107	J	$a = b*\sin c$
G108	J	$a = b*\cos c$
G109	J	$a = \tan^{-1} b/c$
G110	J	$a = \sqrt{b^2 - c^2}$
G200	J	Unconditional branch
G201	J	Null condition branch
G202	J	Negative condition branch
G203	J	Bit test

EXPLANATION OF I AND J

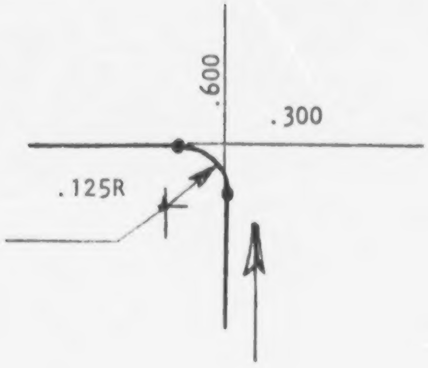
The I and J define the center point of the arc from the point the arc begins. I relates to the X axis and J relates to the Y axis.


1.00
.500
.050R

```
G01X9500Y500
G02X10000Y4500I0J-5C0
```



```
G01X6200Y8500
G03X6500Y8800I0J300
```

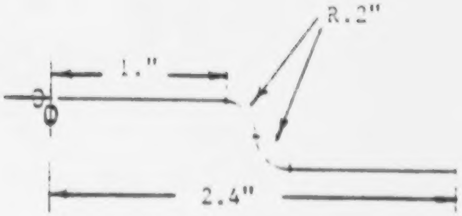

.600
.300
.125R

```
G01X6000Y1750
G03X4750Y3000I-1250J0
```

ARC DEFINITION

Generally there are four parts to an arc.

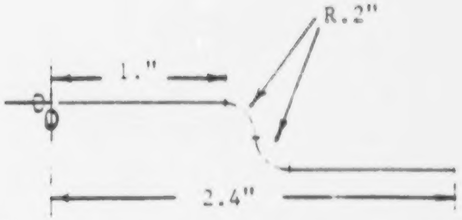
1. <u>Start Point of Arc</u> - this is designated with an X and Y coordinates on the line prior to the arc.
2. <u>Direction</u> - this is designated using a G02 and G03, simply meaning clockwise and counter clockwise respectively.
3. <u>End Point of Arc</u> - this is designated with X and Y coordinates on the G02 or G03 line.
4. <u>Center Point of Arc</u> - this is designated using I and J coordinates measured from the start point of the arc. I and J are coordinate axes, I is horizontal and J is vertical.



EXAMPLE:

```
G90
G92X0Y0
G01X1.Y0
G02X1.2Y-.2I0J-.2
G03X1.4Y-.4I.2J0
G01X2.4Y-.4
```

It is possible to have the machine calculate the center point of the arc automatically by simply programming an "R Value" in place of I and J.

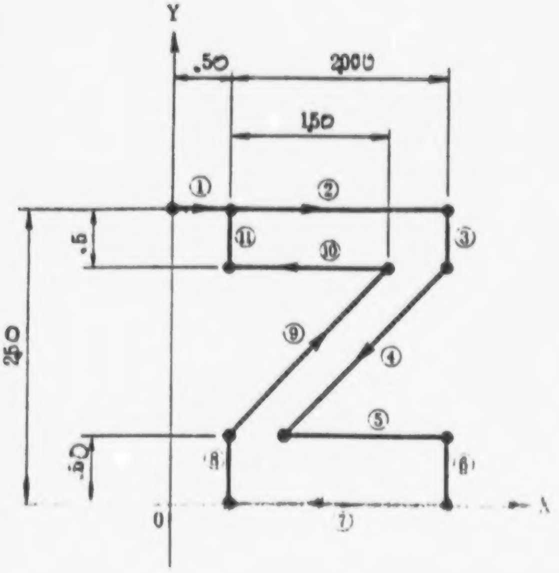


EXAMPLE:

```
G90
G92X0Y0
G01X1.Y0
G02X1.2Y-.2R.2
G03X1.4Y-.4R.2
G01X2.4Y-.4
```

It must be made clear however, that when using an R Value the arc must be broken into 90 degree increments.

Manual Programming on the 90G Wire EDM



```
X    .500
X   2.000
Y   -.500
X -1.500  Y -1.500
X  1.500
Y  -.500
X -2.000
Y    .500
X  1.500  Y 1.500
X -1.500
Y    .500
```

The following steps should be taken when manually programming on the wire EDM using the example shown to the left

1. Push the **DISPLAY** button
2. Push **#4** key on CRT keyboard
3. Push **CANCEL** button to cancel old program
4. Push **INPUT** and the screen will clear
5. Enter M80 PUSH ;/EOB *
6. Enter M82 PUSH ;/EOB
7. Enter M84 PUSH ;/EOB
8. Enter M91 PUSH ;/EOB

Note! When you push the end of block key you will not move to a new line. The machine will separate the lines when push input at end of program.

9. You are now ready to enter the first move or dimension into the machine.* **Note!** when entering any dimensions the decimal point is shifted **4 places to the RIGHT.**

	Examples	
.500	Enter	5000
1.50	Enter	15000
2.0	Enter	20000

10. Enter G92X0Y25000 ;/EOB

11. Continue to enter program as shown on the left, remember to push ;/EOB at end of each move.

*If you make a mistake. See Step 15.

M 8 0 ;/EOB

M 8 2 ;/EOB

M 8 4 ;/EOB

G 9 1 ;/EOB

G 9 2 X 0

Y 2 5 0 0 0 ;/EOB

(1) G 4 1 X 5 0 0 0 ;/EOB

(2) X 2 0 0 0 0 ;/EOB

(3) Y 5 0 0 0 ;/EOB

(4) X 1 5 0 0 0

Y 1 5 0 0 0 ;/EOB

(5) X 1 5 0 0 0 ;/EOB

(6) Y 2 0 0 0 ;/EOB

(7) X 2 0 0 0 0 ;/EOB

(8) Y 5 0 0 0 ;/EOB

(9) X 1 5 0 0 0

Y 1 5 0 0 0 ;/EOB

(10) X 1 5 0 0 0 ;/EOB

(11) Y 5 0 0 0 ;/EOB

M 0 ;/EOB

G 4 0 X — 5 0 0 0

F 6 0 0 0 0 ;/EOB

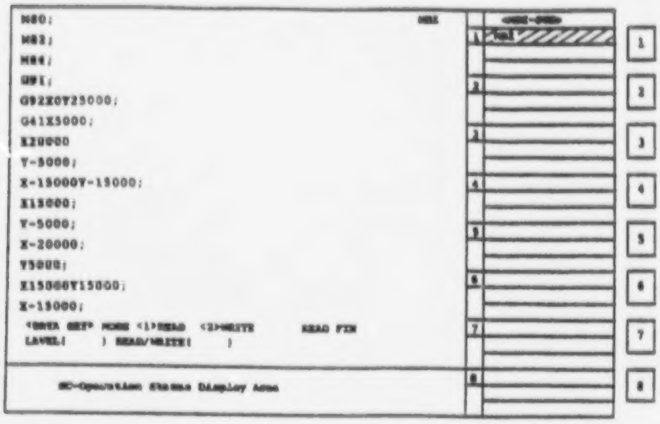
M 2 ;/EOB INPUT

12. Push **INPUT** key to store program.

13. Check the CRT display to be sure program is correct. Figure 3

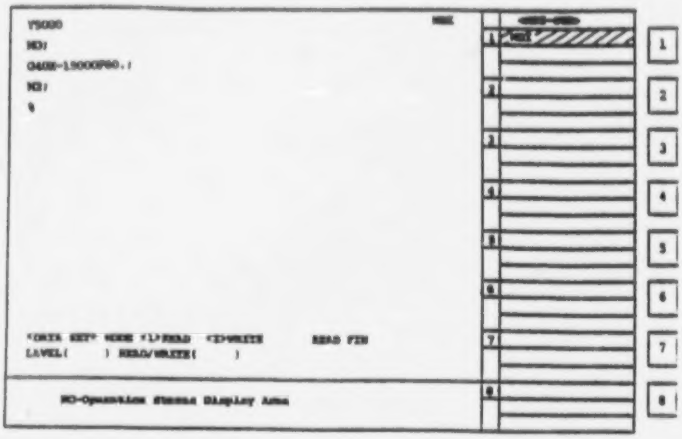
14. Push the **NEXT** key to see end of program.

15. Push **BACK** key to get back to beginning of program. If there are any changes, additions, or deletions to be made, the following steps should be taken:



```
M80;
M82;
M84;
G91;
G92X0Y25000;
G41X5000;
X20000
Y-5000;
X-15000Y-15000;
X15000;
Y-5000;
X-20000;
Y5000;
X15000Y15000;
X-15000;
<DATA SET> MODE <1>READ  <2>WRITE        READ FIN
LEVEL(      ) READ/WRITE(      )

NC-Operation Status Display Area
```



```
Y5000
M30;
G40X-15000Y80.;
M2;
%
<DATA SET> MODE <1>READ  <2>WRITE        READ FIN
LEVEL(      ) READ/WRITE(      )

NC-Operation Status Display Area
```

A. Push arrow keys

↑ ↓ to move cursor

← → to where addition or deletions are to be made

B1. If item is to be deleted push **DELETE** key once for each figure to be removed*

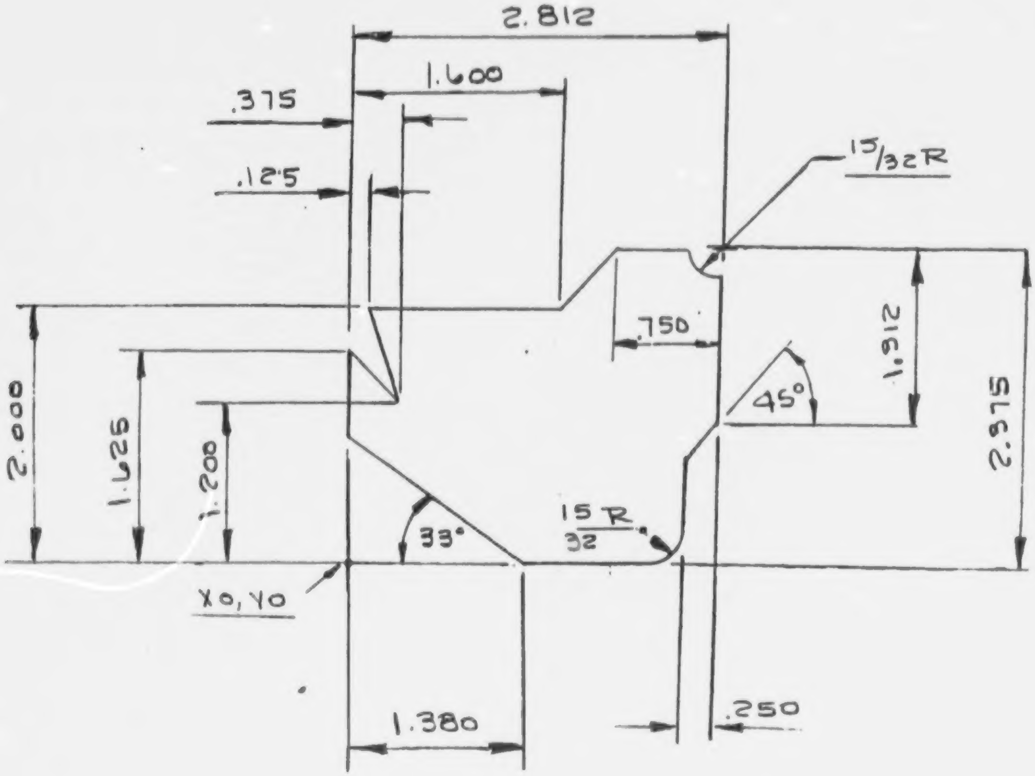
B2. If item is to be changed just enter new information over the information to be replaced*

B3. If information is to be inserted push **INSERT** key and enter in additional information*

C. Push **INPUT** key and new information is stored. *Be sure to push **INPUT** key after any changes are made

16. Check that **READ FIN** is shown at lower left portion of your CRT.

Manually program the part shown below. After you finish, enter it into memory and plot or graph it to see if it is correct.



2.812
1.600
.375
.125
15/32 R
.750
1.312
45°
2.375
2.000
1.625
1.200
33°
15/32 R
X0, Y0
1.380
.250

Notes:

Unit 26

Introduction

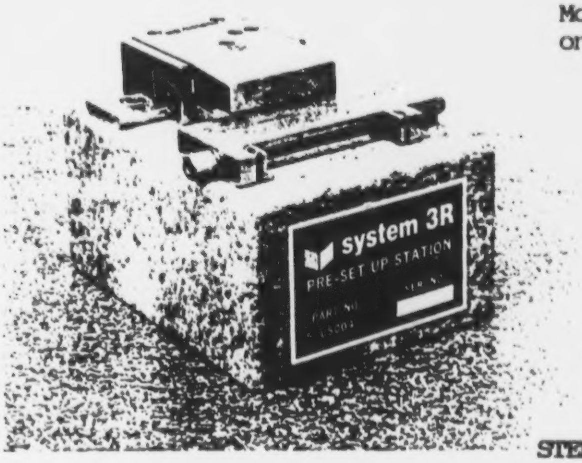
The various tool and fixtures that are used on the wire EDM will be shown and the method of setting up and using these tools and fixtures will be described.

Objectives

Upon successful completion of this lesson the trainee will be able to:

1. Setup location rails on EDM table.
2. Preset workpiece on various types of fixtures.
3. Mount workpieces in special holding devices on the machine.
4. Mount workpieces with basic tooling.
5. Using a special jaw to hold round parts.

PRESETTING BLOCK


system 3R
PRE-SET UP STATION
PART NO.

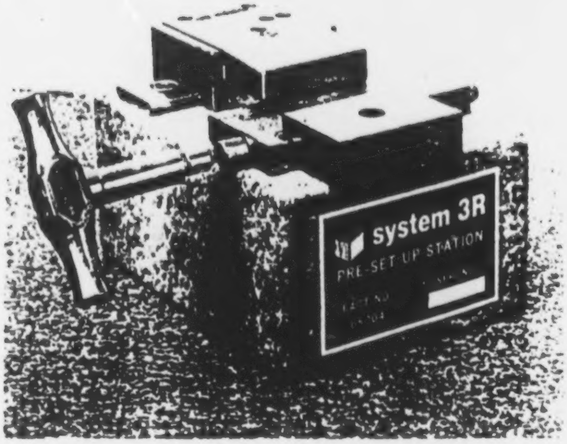
STEP 1

Mount and lock the Supervise and Leveling Head onto the Pre-Setting Block as shown.

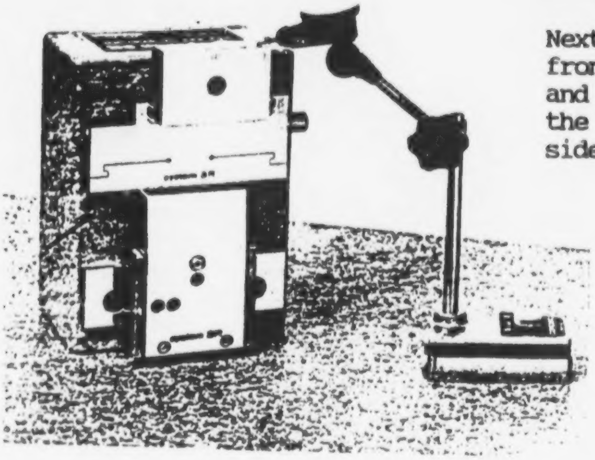
STEP 2

Clamp your workpiece in the Supervise. Tighten the Vise using the torgue wrench, until it slips. This will insure that the correct clamping pressure is applied.

By resting your workpiece on the Pre-Setting Block while tightening the Vise, the bottom surface of the workpiece will automatically be located on your Wire EDM Machine's Zero Line.

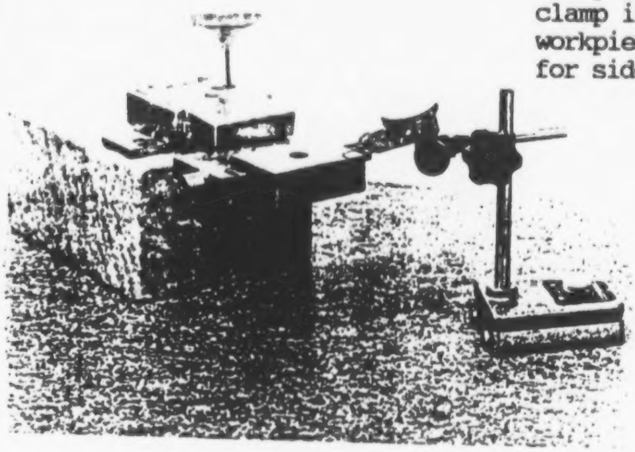

system 3R
PRE-SET UP STATION
PART NO.

STEP 3



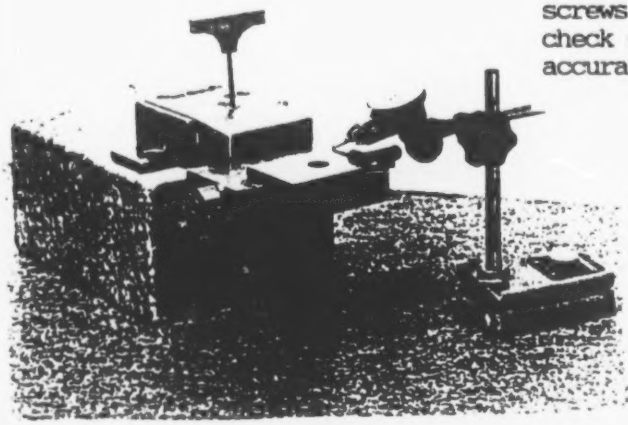
Next, stand the Pre-Setting Block on the lapped front surface, (the side opposite the label), and adjust the X-Y plane of the workpiece using the two adjustment screws located on either side of the Vise, as shown.

STEP 4



Return the Block to its original positon. Unclamp the Leveling Head, turn it 180°, and reclamp it to the block as show. Next, level the workpiece using the adjustment and lock screws, for side-to-side alignment.

STEP 5

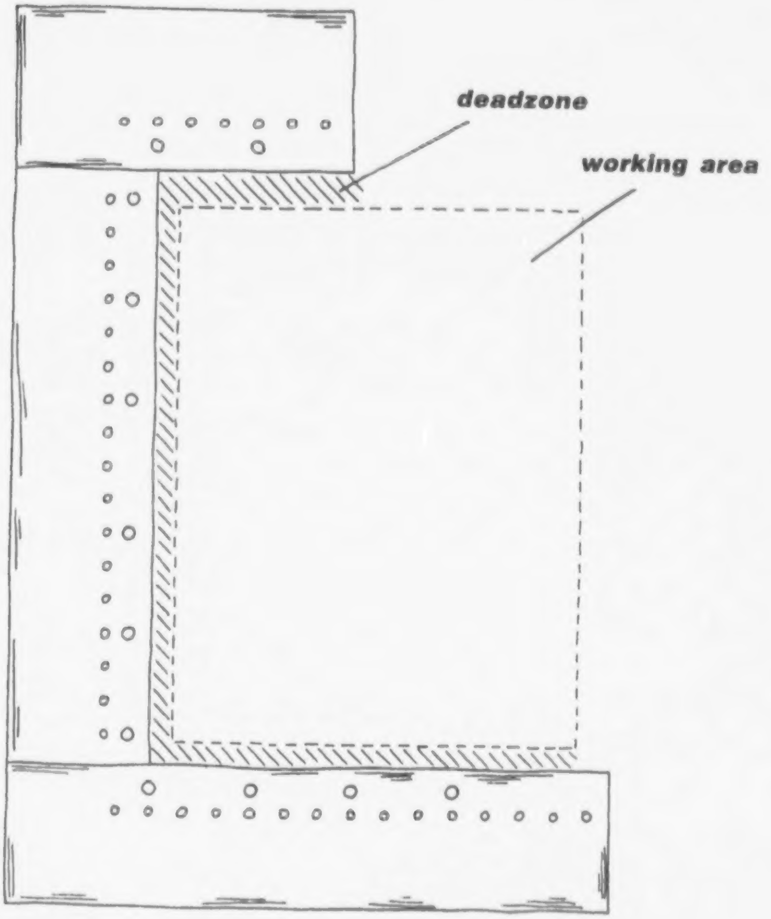


Using the other pair of adjustment and lock screws, level the workpiece front-to-back. Recheck steps 4 and 5 to assure the final accuracy.

THE DEAD ZONE

You who are familiar with the WEDM's know that you cannot cut into the table. The travel of the machine is stopped a certain distance from the table. This distance is on one machine only .375 and on another maybe 1.00.

The workpiece must naturally be placed into the working area of the machine in order to be cut. The smaller the piece is and the closer to the edges of the workpiece you must cut, the greater this problem becomes. In some cases it will be even impossible to cut the piece.

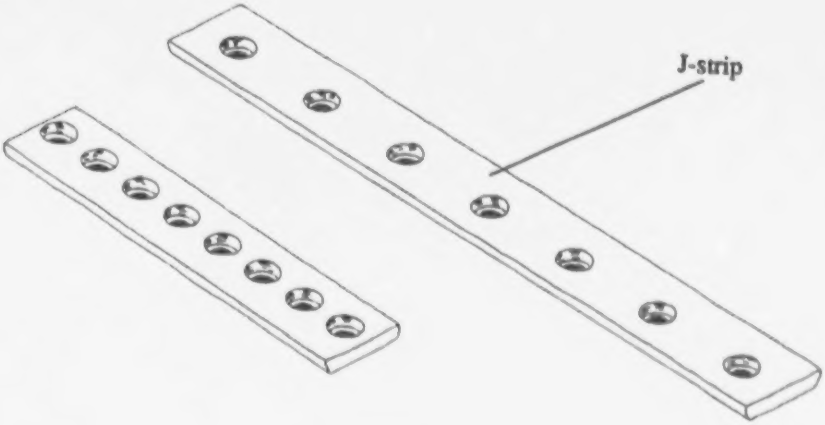


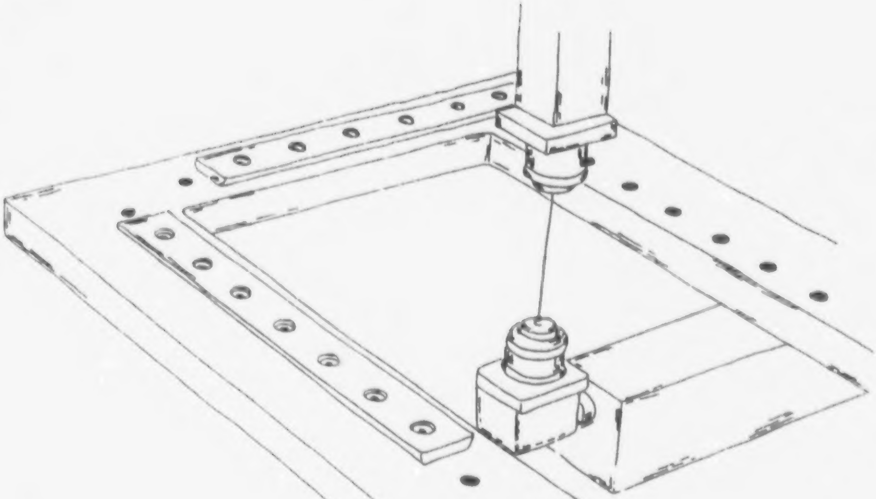
THE TOOLING

Each of these two types are divided into different families of tooling depending on the function of the part in question.

BASE ELEMENTS

The base elements are aligned and fixed in the machine in order to give the machine the 3 references necessary for a full utilization of the machine's capacity and accuracy.

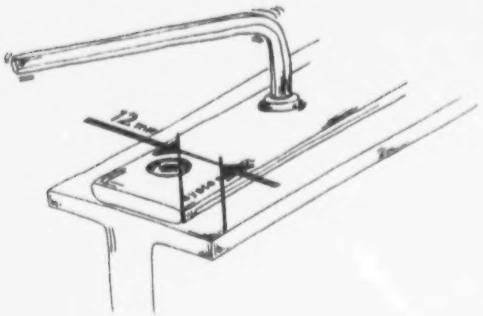




MOUNTING BASE ELEMENTS

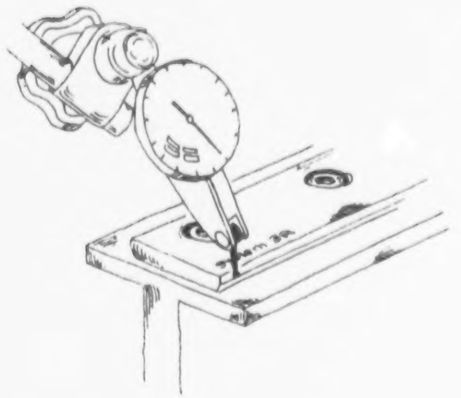
1. Mount the base element in the desired place.

   Do not tighten the screws hard. Alignment can only take place with the base elements mounted snugly.

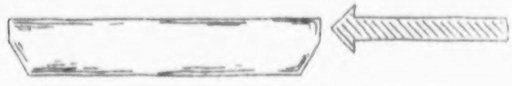


Important: The baseelement is positioned right if it allows a minimum of (.475") to be exposed along the in side edge of the table top.

2. Mount a dial indicator on the upper wireguide of the machine.

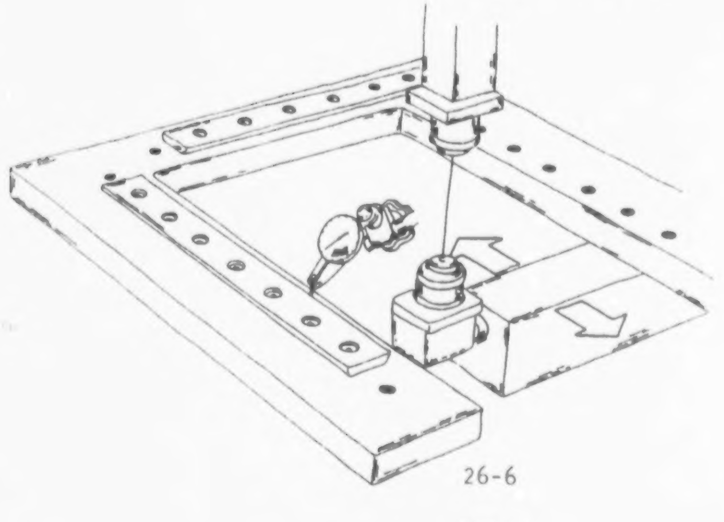


3. The dial indicator should touch the reference surface indicated below.



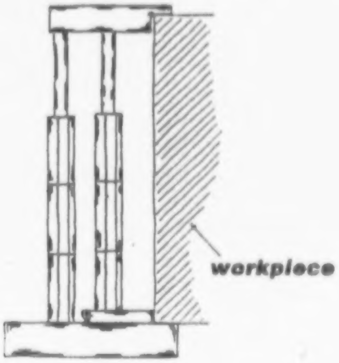
4. Evenly tighten the bolts as you proceed with the alignment.

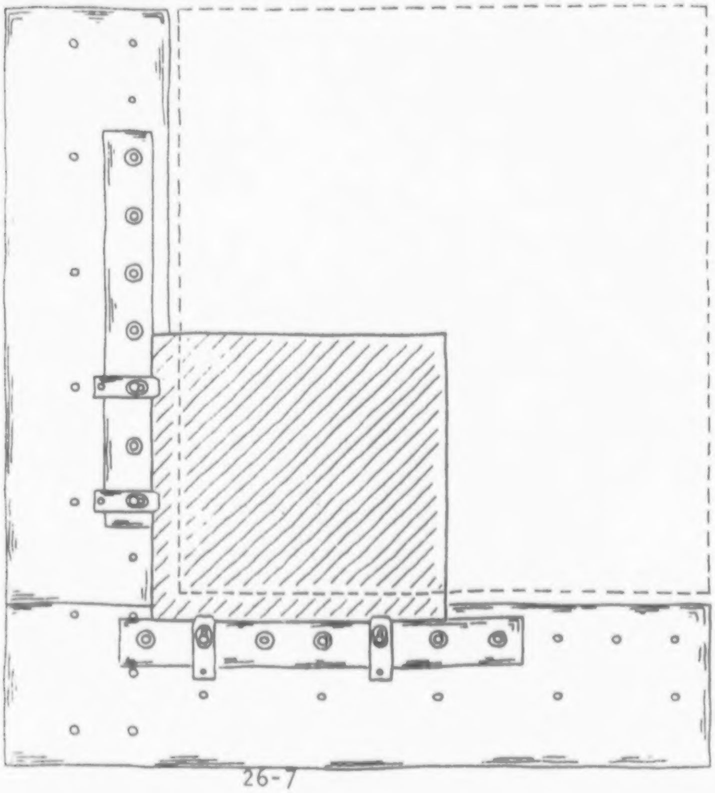
   For easy alignment, make a program that will move the lower arm back and forth along the base element.



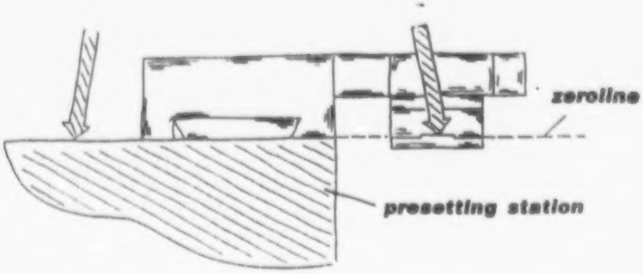
1D SET

By using a 1D kit from SYSTEM 3R, together with the base elements, very large workpieces can be held with regular clamping elements. By exchanging the M8-screws which the base element is secured with to a longer M8 screw and a clamp you can utilize the aligned base elements for references and still mount very large workpieces.



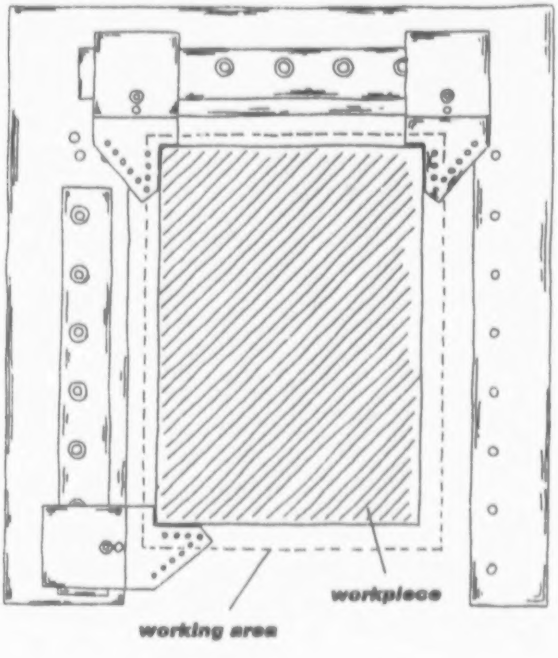


As workpieces become bigger, it becomes impractical or even impossible to preset them. The 3P makes the aligning quick in the machine. The 3P holds the workpiece inside the working area of the machine and carries both round and square workpieces.


zeroline
presetting station

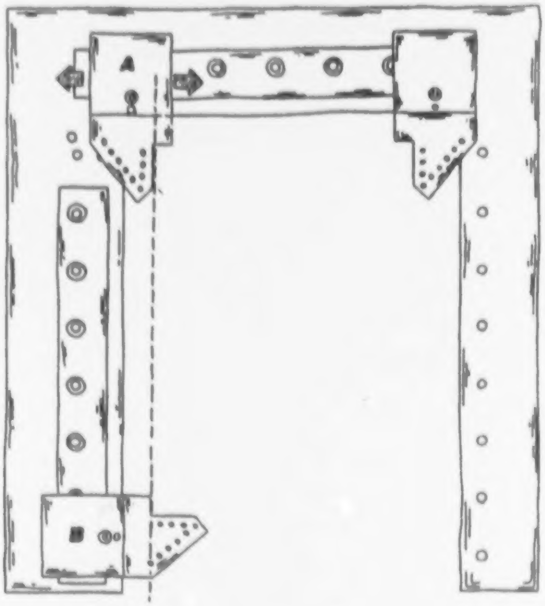
STEP 1

Prepare the work by setting the three holders on the same level at the presetting station. Check the height between the holder and the zero line by touching off on top of the presetting station and on top of the z-axis stop on the holder.


workpiece
working area

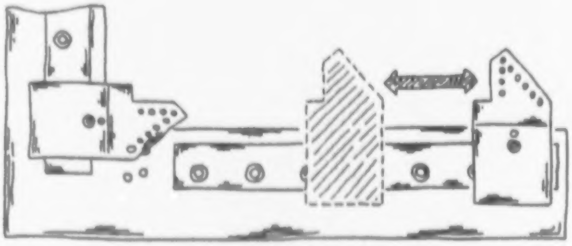
STEP 2

Mount the 3P holders in the machine and check that the holders A and B are on the same line. If not, move holder A.



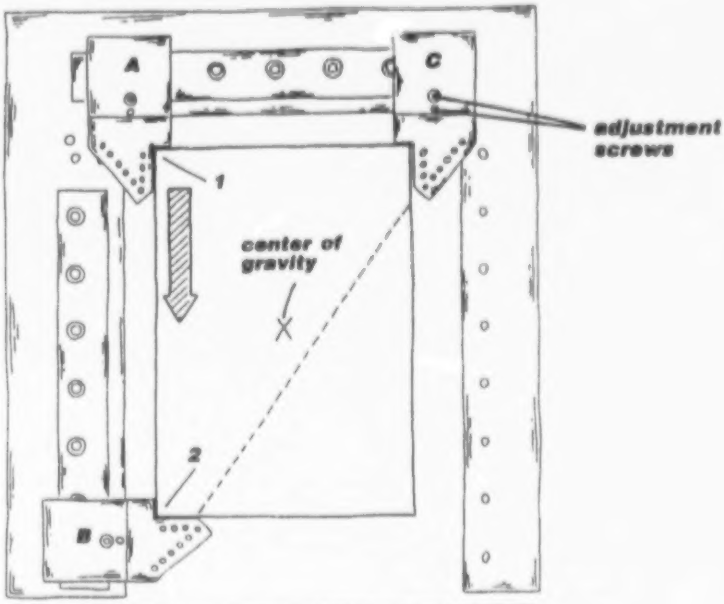
STEP 3

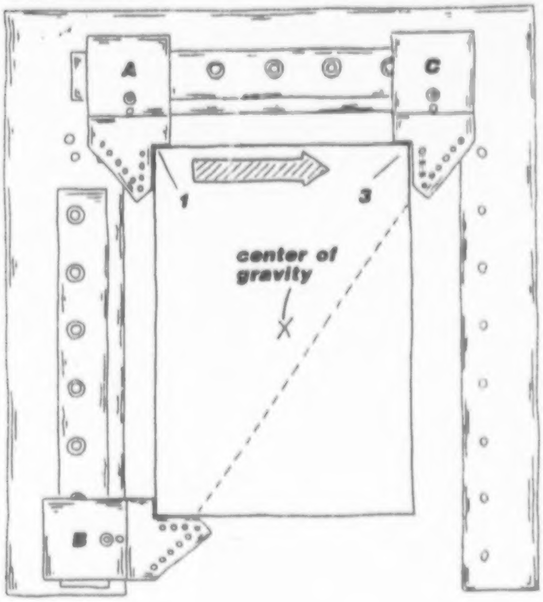
Mount the workpiece and secure it with the clamps. By moving the holders along the base elements different sizes of workpieces can be handled. The center of gravity of the workpiece is inside the line between the two holders B and C, which will help you to load the workpiece easily, even if it is heavy.



The next thing to do is to find out if the workpiece is parallel with the zero line of the machine. Travel from point 1 to the point 2, and adjust the workpiece according to same principals as the levelling adaptor.

The travel from point 1 to piint 3, and repeat the procedure.


A
C
adjustment screws
1
center of gravity
2
B

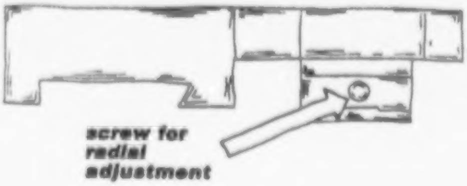

A
C
1
3
center of gravity
B

STEP 5

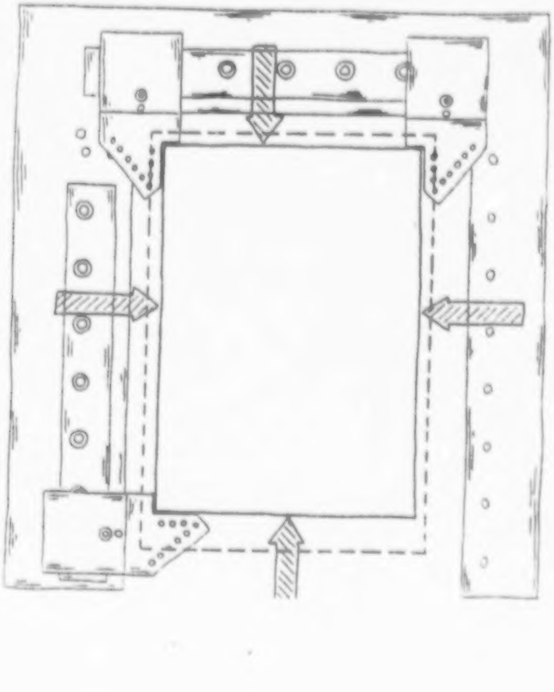
Finally check the alignment of the whole workpiece. You might find out that the tip of the workpiece which is hanging in mid air is slightly bending down. To eliminate this, make an adjustment with holder A.

STEP 6

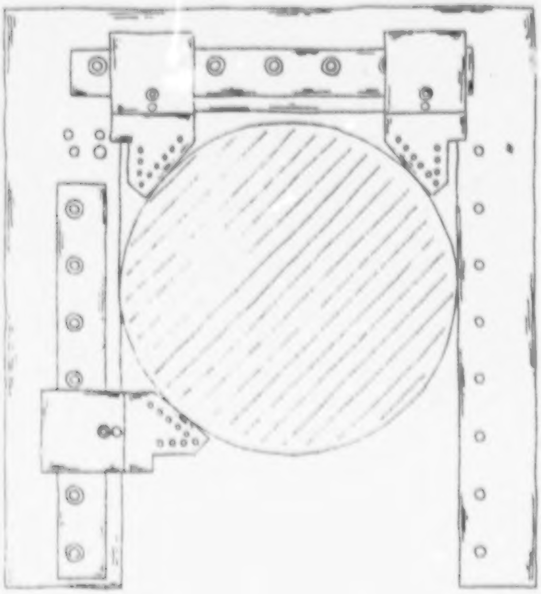
When the horizontal alignment is made, the 3P permits a radial adjustment using the screws in the z-axis end stops.

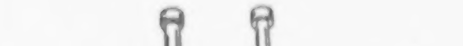


You will have four sides open for contact indication as the workpiece is fully placed in the working area of the machine.



The 3P can also be utilized for round workpieces. In most cases, it is only necessary to switch places of the two holders that are placed on the same base element and turn the jaw of the third holder 180 degrees. You also have to change the places of the z-axis stand-offs.

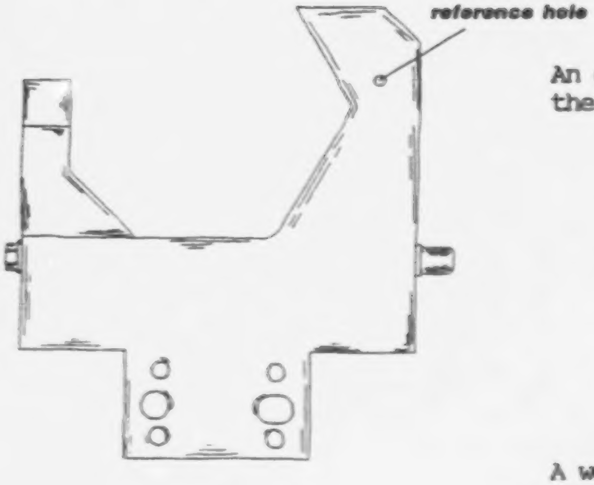




26-12

THE LOBSTER CLAW

The lobster claw is designed for round pieces. The design of holders for round workpieces seldom permits "touch off" indication of a workpiece. This lobster claw is designed with a reference hole which allows you to find the center of the workpiece. Find the center of the hole with the wire and use the formula below to find out the travel in x and y.



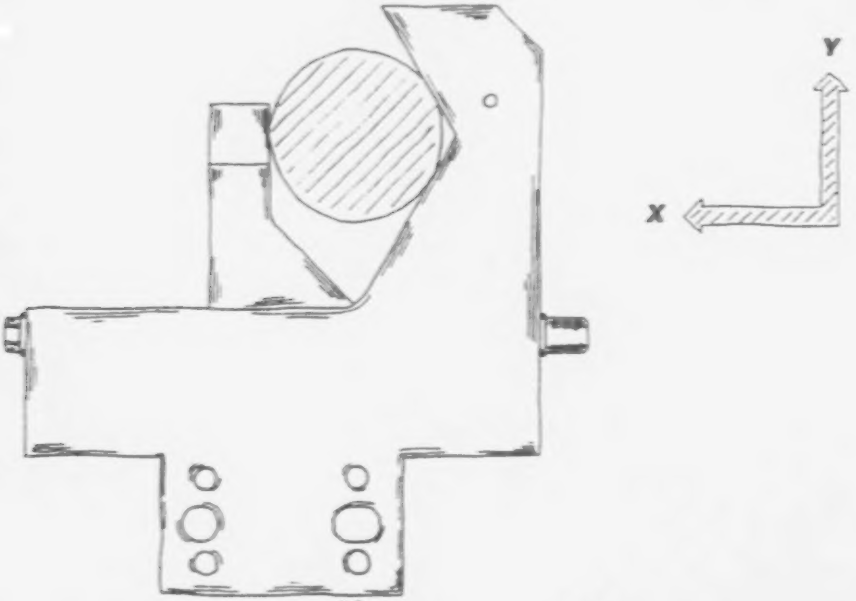
An example would be, if we had a workpiece with the OD of 1.970

$X = (D \div TAN60^{\circ})+393$

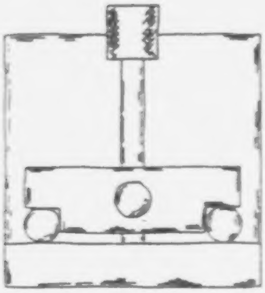
$X \quad (1.970 \div 1732)+393$

$X = 1.5304$

A workpiece with coarse outside will immediately eliminate the possibilty to use the reference hole if the workpiece is to be manufactured with tight tolerances.



SWIVEL SPACER

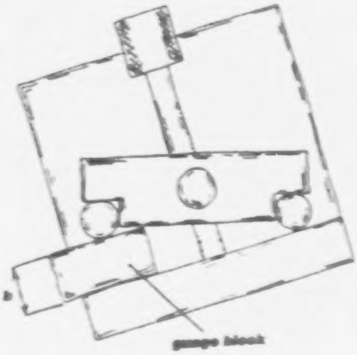


Together with a sine bar and a presetting station any angle can be preset.

STEP 1

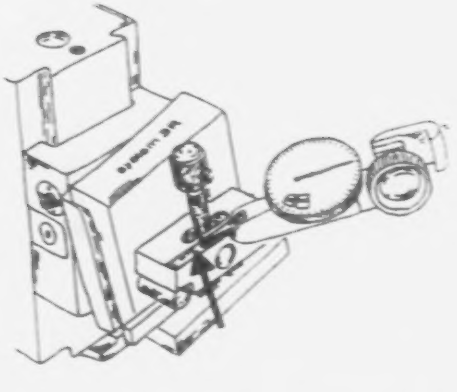
The angle you would like to set will easily be accomplished with the swivel spacer and the sine bar mounted as below. The sine bar has magnets which will hold the sine bar in position. The top surface of the swivel spacer is parallell to the dovetail which ensures you a perfect setting.

Use the formula below to find out what size of guageblock to use in order to set the right angle.

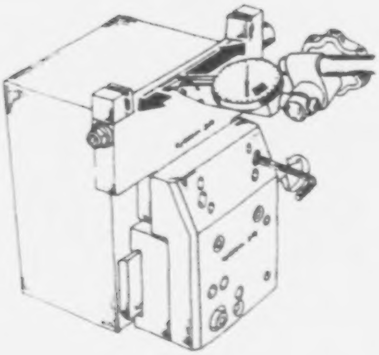


STEP 2

Indicate on the full length of the sine bar until the sinebar is on "zero".



PRESETTING

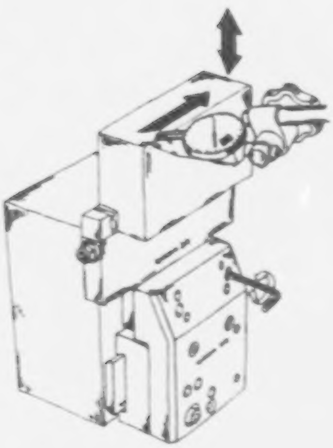


STEP 1

Make sure that the reference surface on the vice and the dovetail of the levelling adapter are parallell by using the method shown below.

STEP 2

Load the workpiece in the vice and tighten the vice, preferably with a torque limiter (3R-914-07alt3R-US005), in order to repeat the position of the workpiece in the vice.



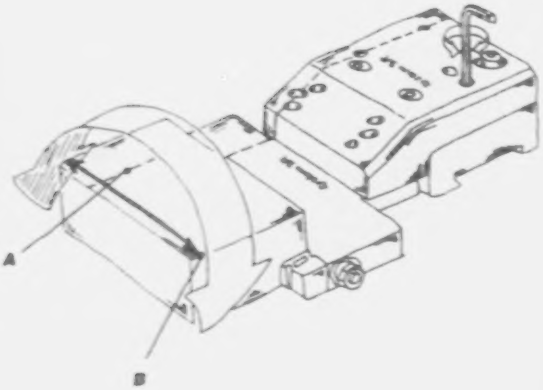
STEP 3

Check the parallelism between the workpiece and the dovetail of the levelling adapter by indicating along the surface shown below.

If adjustment is necessary, use the excentric screw to skew the workpiece into position.

STEP 4

Start with dial indicator set on "zero" at position A on the workpiece (on the extended line of where the stainless balls are located.).



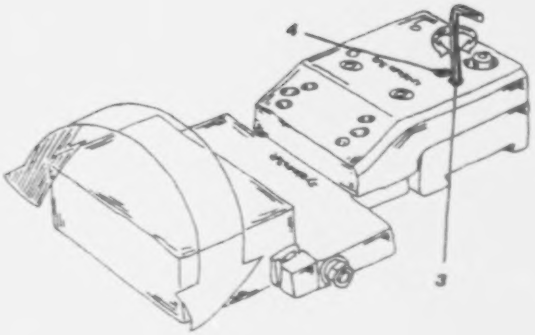
STEP 5

Move the dial indicator to position B, and read off the value.

STEP 6

Adjust back to "zero" using the two set screws 3 and 4. Screw #3 will allow you to adjust the workpiece side to side. Screw #4 will lock at the desired position. Tighten the screws gradually.

AND CHECK THE ALIGNMENT

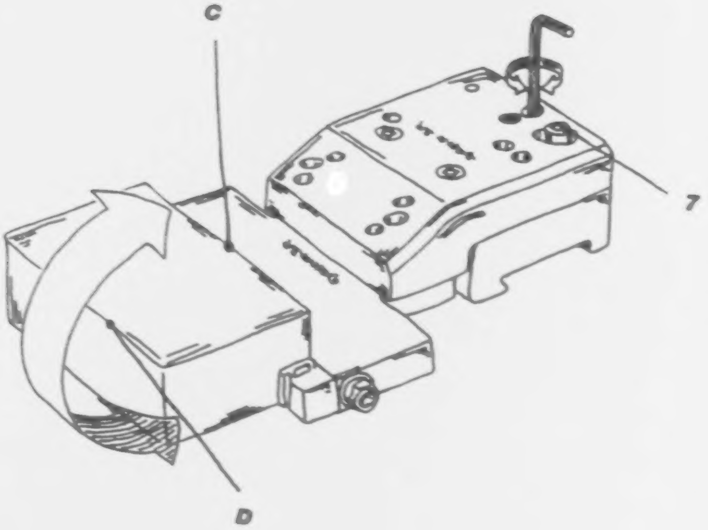


STEP 7

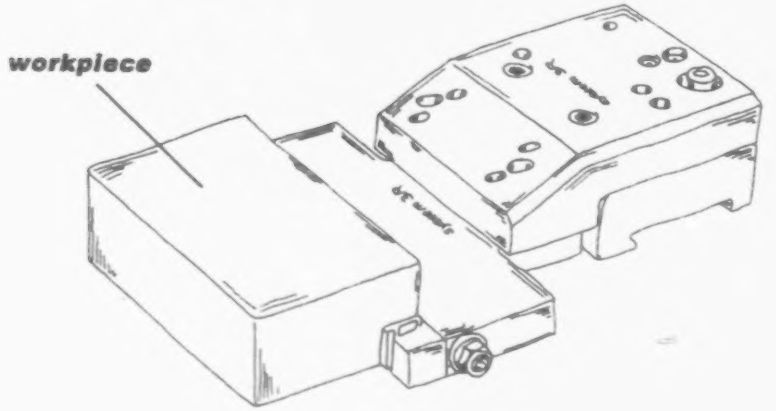
Start at position C with the dial indicator on "zero" for alignment of the other axis.

STEP 8

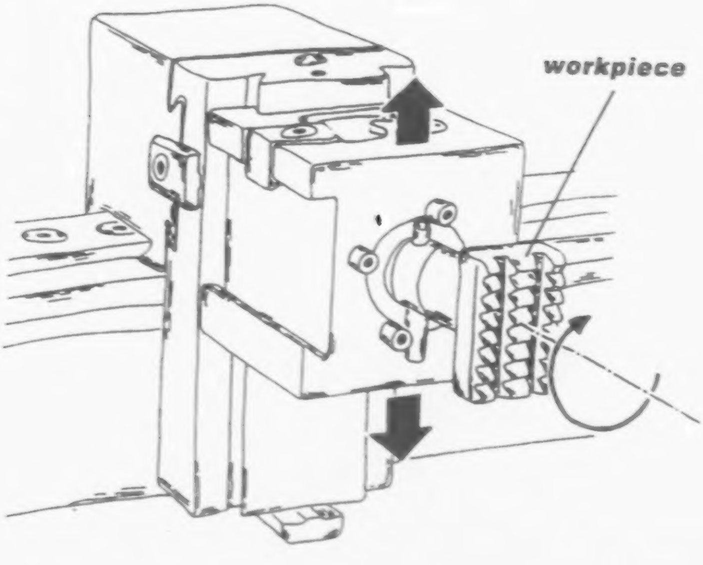
Read off the value at position D.



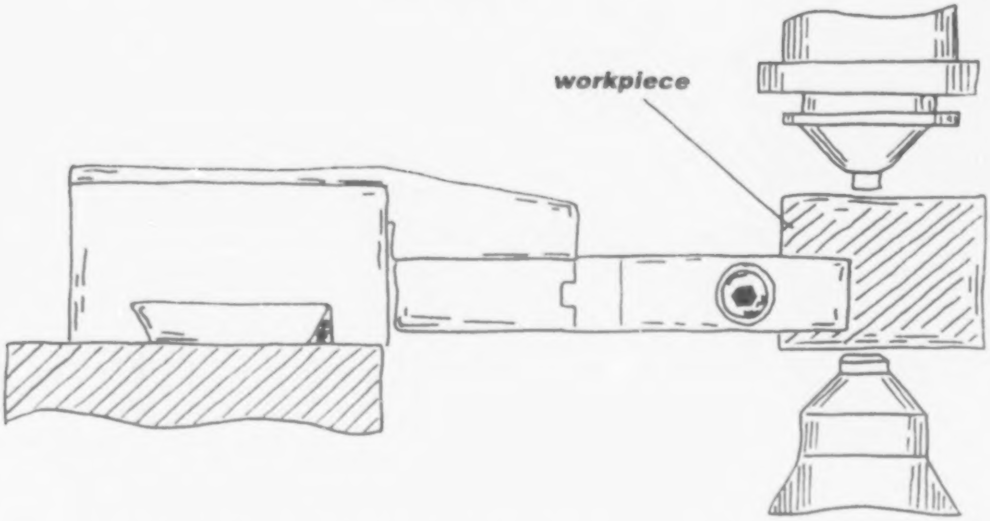
2D applications are applications in the WEDM, where none or only slight adjustments are necessary. The workpiece is held stationary until the cut is finished. 3D applications are those where a workpiece is to be indexed or swivelled in the machine.



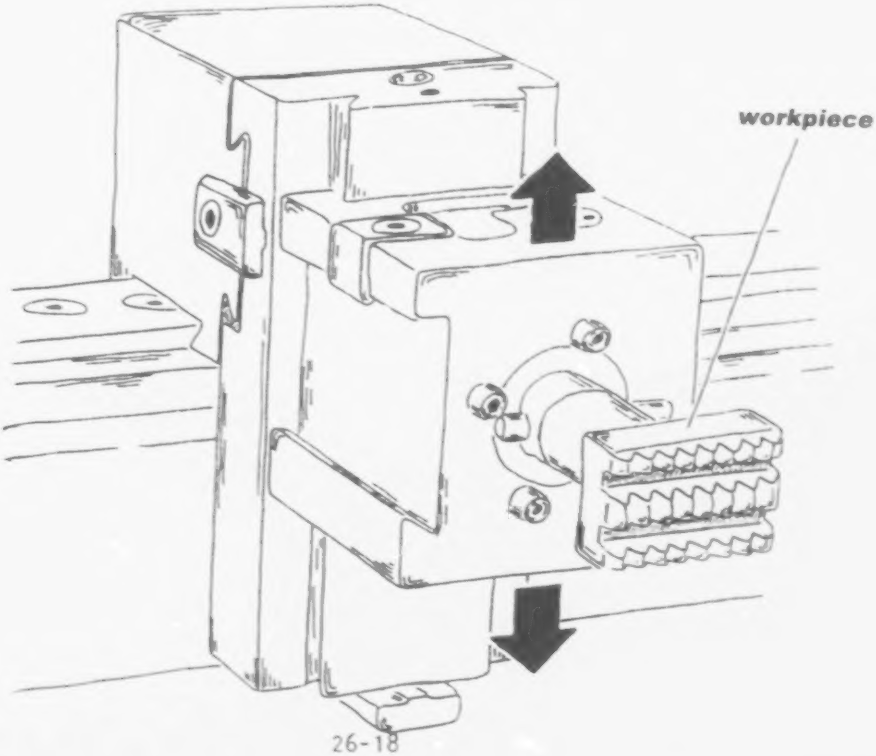
2D



3D

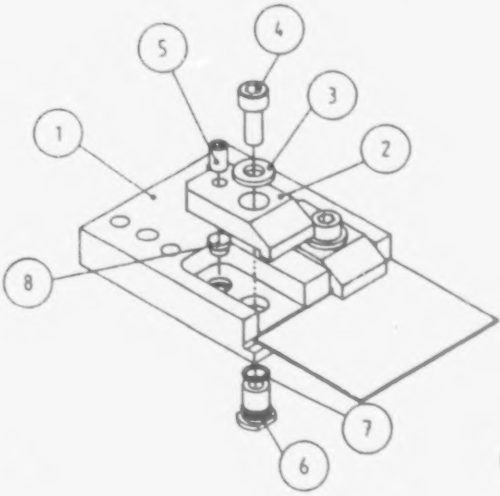


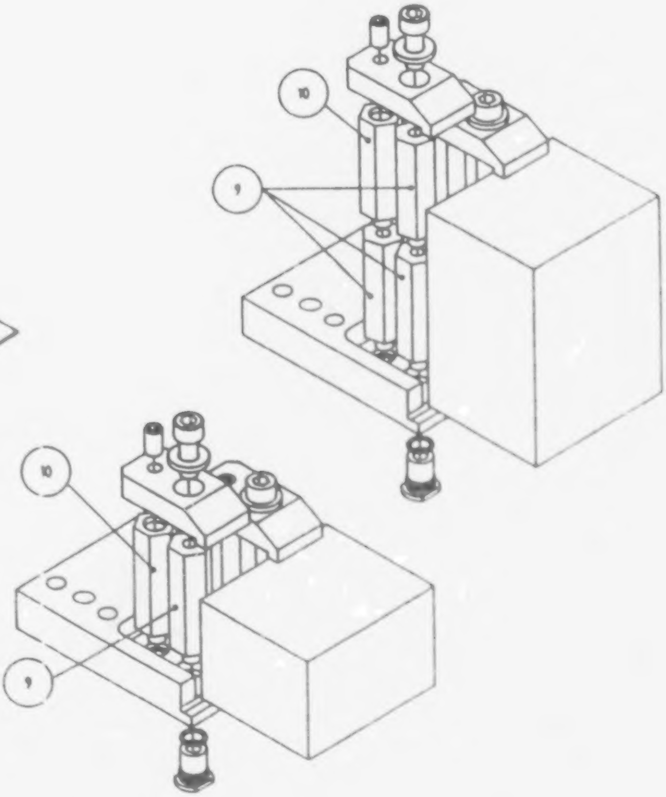
The picture above shows a workpiece held in the 3R Supervice and 3R Levelling Adapter to avoid collision between the tooling/workpiece and the upper/lower wireguides. Below, indexing is the major advantage, and the workpiece is held with 3D tooling.



EDGE HOLDING FIXTURE

The fixture shown below can be used to mount various thickness blocks over the edge of the table when there is not much room for clamping the part. Various size spacers are supplies to accommodate different height workpieces.

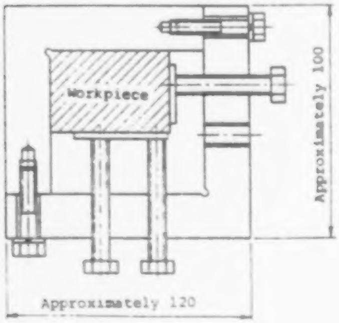




	Name
1	Holder
2	Clamp
3	Washer
4	Screw
5	Set screw
6	SleeVe
7	O-ring
8	Stud
9	Spacer
10	Spacer

BASIC FIXTURES FOR HOLDING A PART

The fixtures shown below are basic homemade type of fixtures that can be used to hold a part on the wire EDM.


Workpiece
Approximately 100
Approximately 120

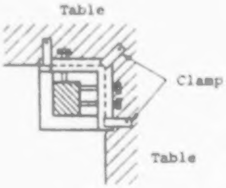
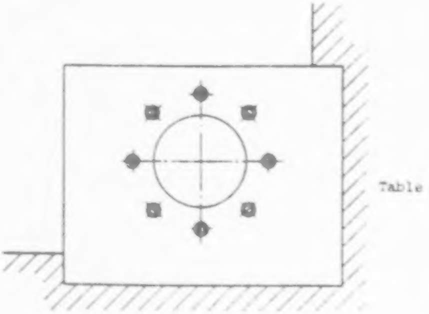


Table
Clamp
Table



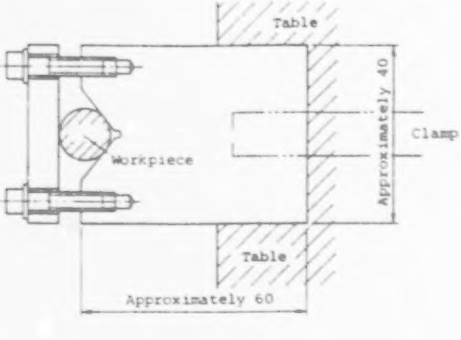
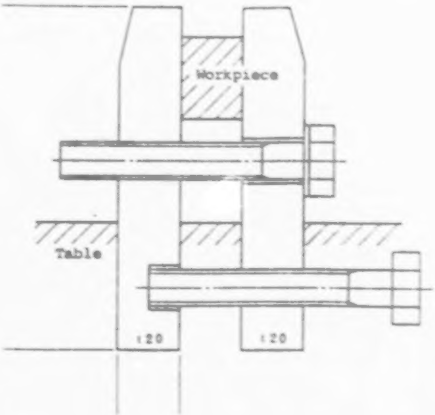


Table
Workpiece
Approximately 40
Clamp
Table
Approximately 60


Workpiece
Table
±20
±20

Notes:

Unit 27

Introduction

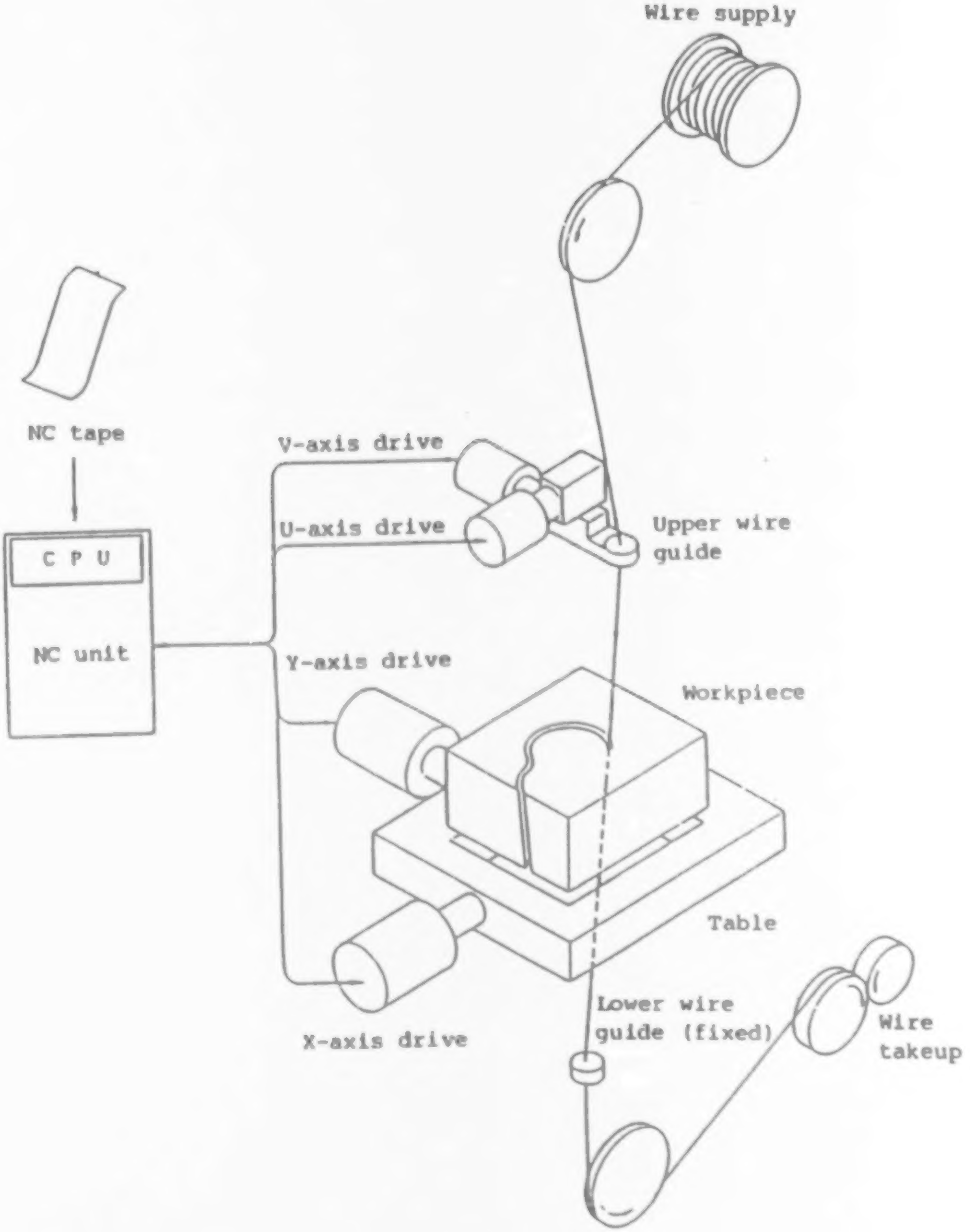
An explanation is on setting up and cutting various angles on tapers on the Wire EDM.

Objectives

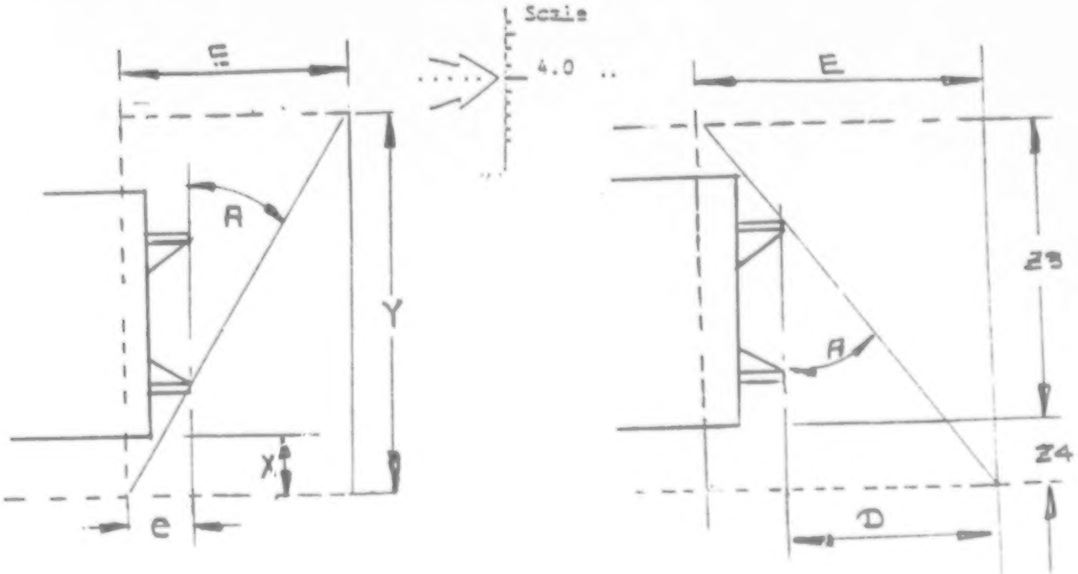
Upon successful completion of this lesson, the trainee will be able to:

1. Determine + or - setting for direction of taper on machine.
2. Calculate five steps for taper setting.
3. Set "G" codes for corner radii.
4. Cut a taper for a die with or with a land.

TAPER CUT DEVICE


Wire supply
NC tape
V-axis drive
U-axis drive
C P U
NC unit
Upper wire guide
Y-axis drive
Workpiece
Table
Lower wire guide (fixed)
Wire takeup
X-axis drive

CALCULATION FORMULA FOR Z3 AND Z4



MACHINE SETTING

Taper Angle________

Tension Setting________

Pretension Setting________

Initial Y = 4.6 (Reference for First Calculation)

Calculate Items	No. 1	No. 2	No. 3
E = Y X Tan(A)			
C			
D			
$X = \frac{(2.1654 x C) - (.1969 x D)}{D - C}$			
$Y = \frac{E (.1969 + X)}{C}$			
$A = Tan \left(\frac{E}{Y}\right)$			
3 = Y - X Z3 = Z3 - Scale (4.0)			
Z4 = X			

See the following pages to calculate the above information.

CALCULATING Z3 AND Z4 FOR CUTTING TAPER

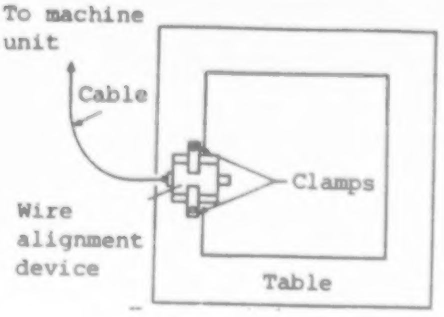

To machine unit
Cable
Clamps
Wire alignment device
Table

Figure 1

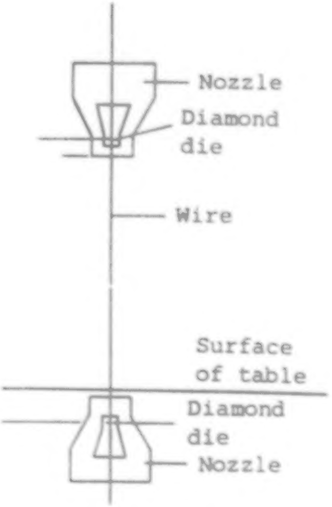

Nozzle
Diamond die
Wire
Surface of table
Diamond die
Nozzle

Figure 2.

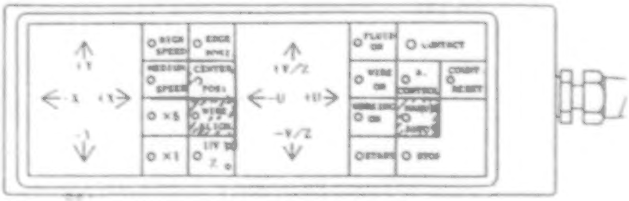

HIGH SPEED
EDGE
MEDIUM SPEED
CENTER POS.
×5
WIRE ALIGN
×1
+Y
-X
+X
-Y
+V/Z
-U
+U
-V/Z
CONTACT
WIRE ON
A. CONTROL
COUNT RESET
START
STOP

Figure 3

1. Clamp perpendicular gage on table. Figure 1.
2. Set Z axis scale at 4.000". Figure 2.
3. Set wire perpendicular using wire alignment button. Figure 3
4. Push Display button.
5. Press #1 position.
6. Note rel-positon reading.
7. "O" out U and V to do this
   press: U button and CB button
   press: V button and CB button
8. Turn wire on and move table X axis at Medium Speed and then at .0005 .0001 until wire contact light goes on.
9. Turn off wire.
10. "O" out X and Y
    press: X button and CB button
    press: Y button and CB button
11. Check clearance angle required on die.
12. Calculate the E value by using 4.6 as the Y value.

    Example: 4.6XTAN (1°)-08029
13. Jog U axis to E value in the (+) direction.
14. Turn on wire.
15. Jog the X axis in the (-) direction until the wire touches the lower sensor of the gage (lower light on gage will go on).
16. Turn off wire.

17. Write down the C value shown on the X relative position.

18. Jog the table in the X + direction about 1/2 inch.

19. Jog the U axis to the value E in the - direction.

20. Turn wire on.

21. Jog the X axis in the - direction until the wire touches the upper sensor of the gage.

22. Write down the D value as shown on the X relative position.

23. Jog U axis to O (perpendicular).

24. Calculate X, Y, and A, using the formulas shown below.

Note! You must recalculate if the A (angle) is different by more than 45 seconds from the taper angle used in step 8. Make a test cut to confirm the Z3 and Z4 values after the final calculation is complete.

MACHINE SETTING

Taper Angle__________

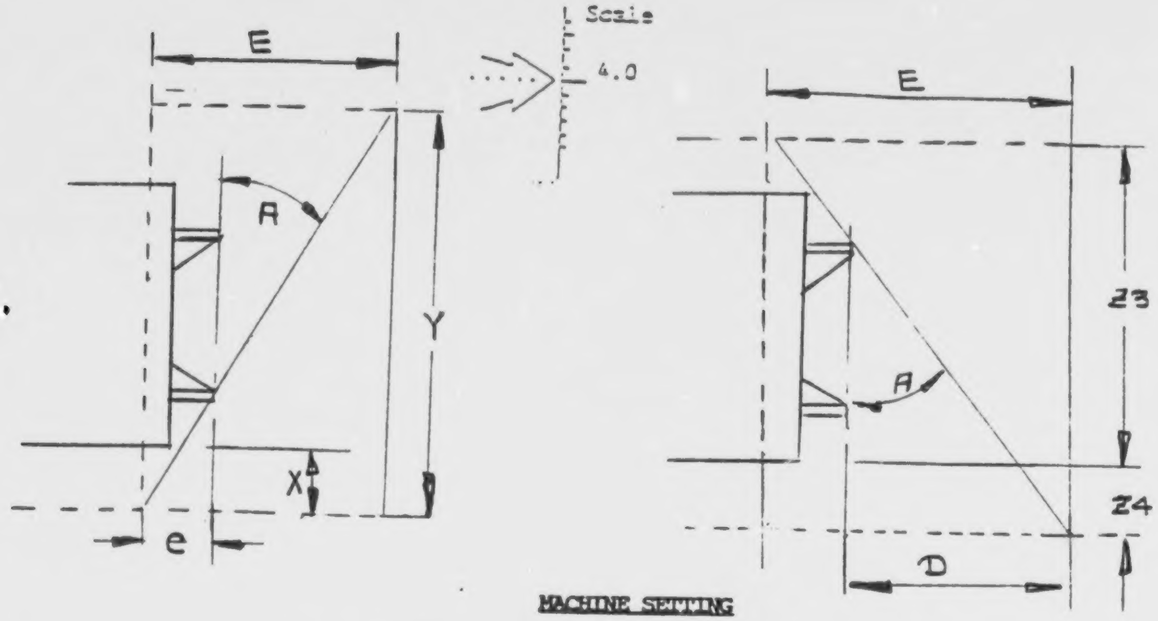
Tension Setting__________

Pretension Setting__________

Initial Y = 4.6 (Reference for First Calculation)

Calculate Items	No. 1	No. 2	No. 3
$E = Y \times \mathrm{Tan}(A)$			
C			
D			
$X = \frac{(2.1654 \times C) - (.1969 \times D)}{D - C}$			
$Y = \frac{E\,(.1969 + X)}{C}$			
$A = \mathrm{Tan}\left(\frac{E}{Y}\right)$			
$3 = Y - X$ $Z3 = Z3 - \mathrm{Scale}\ (4.0)$			
$Z4 = X$			

CALCULATION FOR Z3 AND Z4



MACHINE SETTING

Taper Angle__________

Tension Setting___________

Pretension Setting___________

Initial Y = 4.6 (Reference for First Calculation)

Calculate Items	No. 1	No. 2	No. 3
$E = Y \times \tan(A)$			
C			
D			
$X = \frac{(2.1654 \times C) - (.1969 \times D)}{D - C}$			
$Y = \frac{E\,(.1969 + X)}{C}$			
$A = \tan\left(\frac{E}{Y}\right)$			
3 = Y - X Z3 = Z3 - Scale (4.0)			
Z4 = X			

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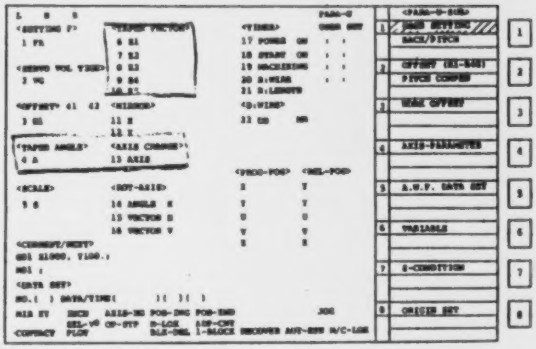
CUTTING A TAPER

To cut a taper on the Wire EDM, the following steps should be taken.*

1. Determine taper angle required for the die.

   A. To do this, we must first decide if the value is to be a + or -. See following page. The sign of the angle is defined a plus (+) or minus for clockwise or counter clockwise deviation, relative to the direction of the process.



2. Enter + or - angle into #4 on Parameter User screen.

   A. Press Display button.

   B. Push #2 Parameter User screen.

   C. Push #4 Taper Angle.

   D. Enter in angle as shown below.

Example 1 A 2° would be entered 20000

Example 2 A 2° 38′ 30" would be entered 2 38 30 or in decimal a 2.6416

*Before setting up the part to cut your taper, be sure you have all the Z calculations determined. If you do not, see page to .

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DIFFERENCE IN ANGLE ± A

DUE TO OFFSET DIRECTION

Example: punch

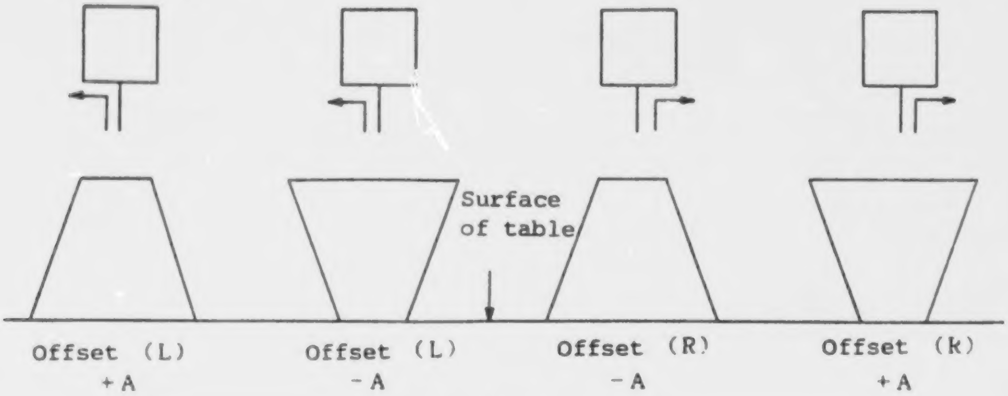

Surface
of table
Offset (L)
+ A
Offset (L)
- A
Offset (R)
- A
Offset (R)
+ A

Figure 1-41

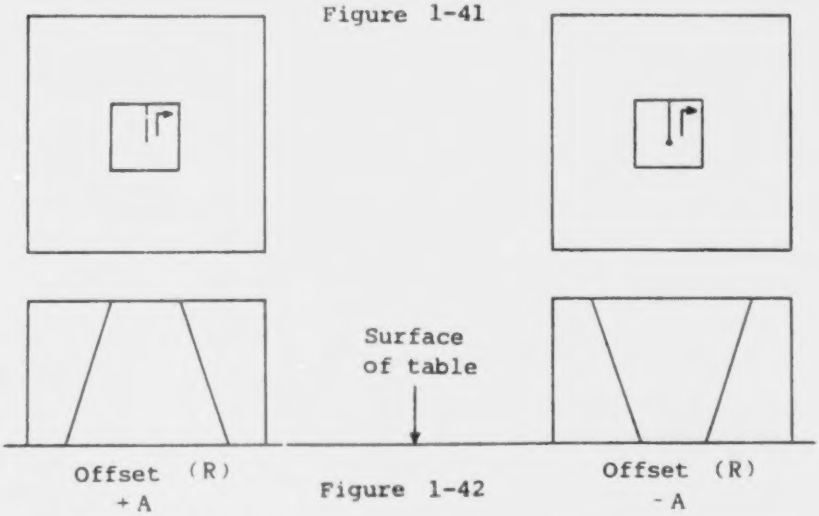
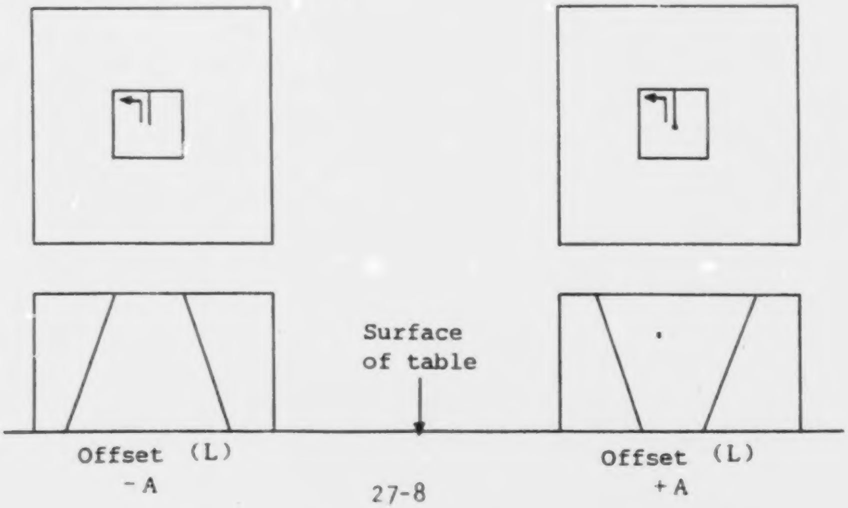

Surface
of table
Offset (R)
+ A
Offset (R)
- A

Figure 1-42


Surface
of table
Offset (L)
- A
Offset (L)
+ A

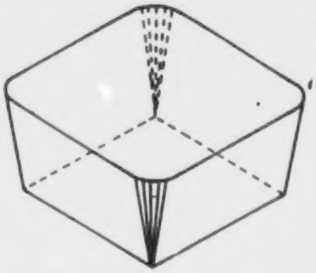


Figure 3

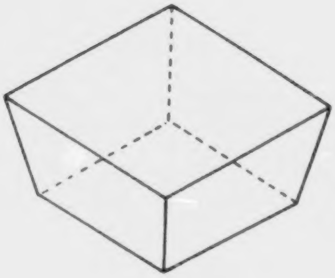


Figure 4

3. An angle command only becomes effective after the offset command (G41 & G42) No angle can be used without specifying G41 or G42.

   Note! an angle command exceeding 60° creates a program error.

   Note! For manual programming

   A. G88 conrer R interpolation. (See Figure 3) When the input G88 is entered the R interpolation mode for all the corners are selected.

   B. G89 interesection calculation interpolation. (See Figure 4) When the input G89 is entered the intersection calculation interpolation mode all the corners are selected.

   The corner mode will automatically go back to G89 by pressing the reset or programming M2.

4. Enter in all Z values on Parameter User screen 6 to 10.

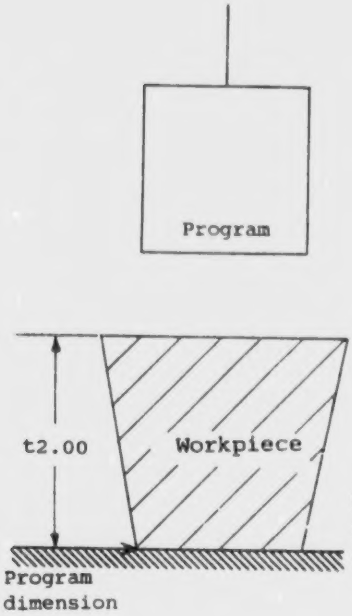
   See the following page.

5. Z1 through Z5 will NOT clear when pushing reset button but are NOT effective unless a taper value at 4 is shown. The taper value WILL clear when pushing reset button.

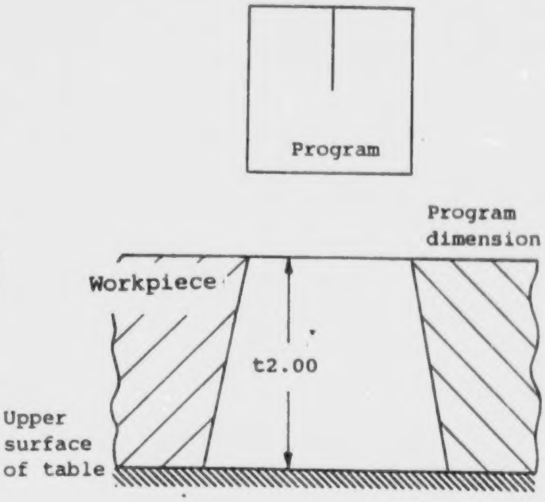
SETTING OF VARIOUS Z FACTORS BEFORE TAPER MACHINING

Setting Of Program Dimensions Height (Z1)

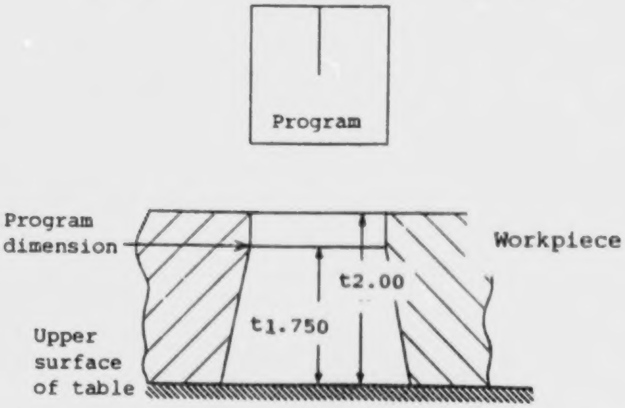
Z1 is the factor indicating the height of the workpiece at which the machining of the program dimension is to be effected, and is unrelated to the angle A of the product or the sign of A.


Program
t2.00
Workpiece
Program
dimension

Z1=0


Program
Program
dimension
Workpiece
t2.00
Upper
surface
of table

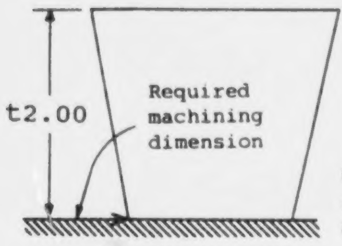
Z1-2.00


Program
Program
dimension
Workpiece
t2.00
t1.750
Upper
surface
of table

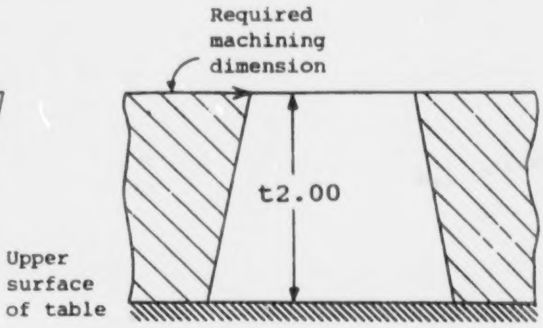
Z1=1.750

Setting Of Feed Speed Height (Z2)

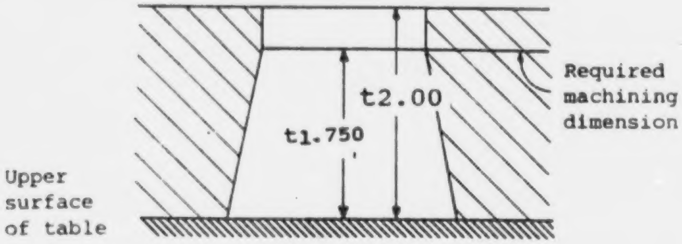
Z2 indicates the height of the feed speed F. When taper machining, the machining speed varies through the vertical direction of the workpiece, so the position (height) on the workpiece for which the feed speed F is designated must be indicated. For ordinary machining, specify the height at which the workpiece requires the given machining dimension (same value as Z1).


t2.00
Required
machining
dimension

Z2=0


Required
machining
dimension
t2.00
Upper
surface
of table

Z2=2.00


t2.00
t1.750
Required
machining
dimension
Upper
surface
of table

Z2=1.750

Setting Of Upper Guide Span (Z3)

Z3 is set, according to the thickness of the workpiece.

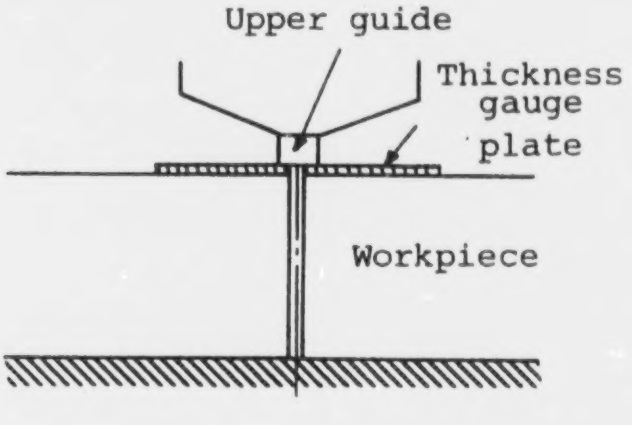
$$Z3 = \text{scale reading} + \ Z3$$

Setting Sequence

1. Place the workpiece and thickness gauge (.004) on the table, and lower the upper guide.
2. Read the value on the scale when the edge of the upper guide makes contact with the thickness gauge.
3. For example, the scale reading in the figure is 1.027.
4. Thus, if the correction value (Z3) is .285, then the value of Z3 becomes

$$Z3 = 1.027 + 285$$

$$= 1.3125$$

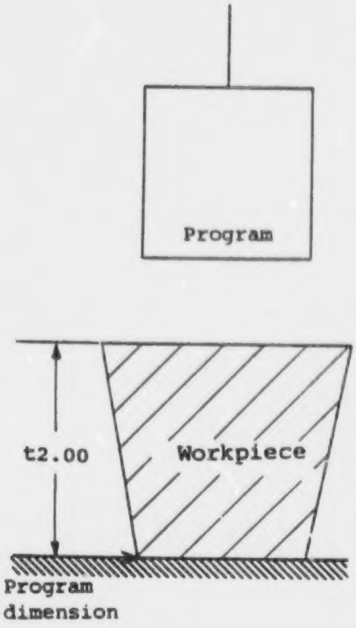


Setting Of The Lower Guide Span (Z4)

The value of Z4 is independent of the plate thickness of the workpiece. Therefore, once the value of Z4 is determined either before the first taper machining or after the replacement of a wire guide die, the distance remains constant, even if the workpiece is changed. The value of Z4 was .3125.

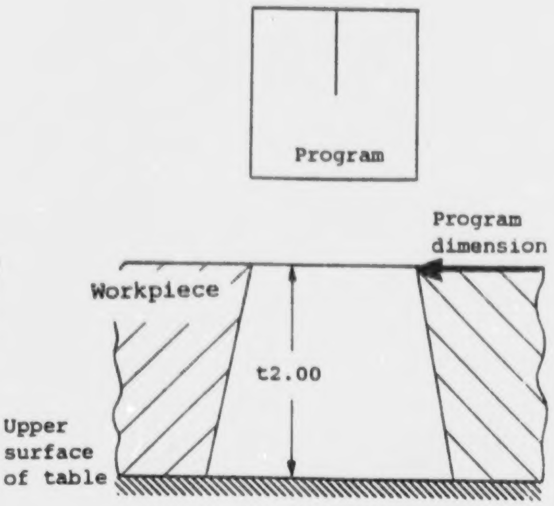
Setting Of Height Specification (Z5) of Arbitrary Shapes

Z5 specifies the height of the configuration when machining a vertically nonuniform shape. For ordinary taper machining, specify the value of Z5 so that Z1 and Z5 span the required part of the workpiece.


Program
t2.00
Workpiece
Program
dimension

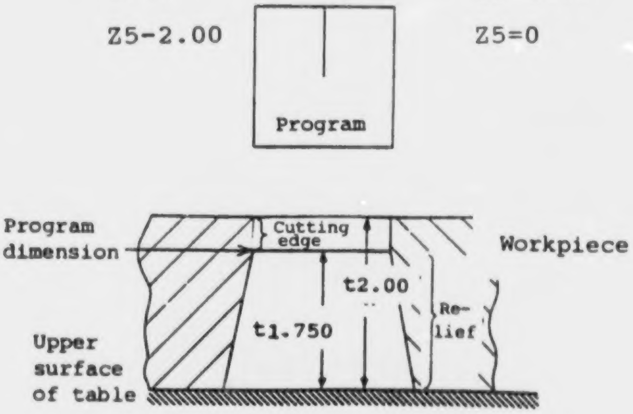
Z1=0

Z5-2.00


Program
Program
dimension
Workpiece
t2.00
Upper
surface
of table

Z1-2.00

Z5=0


Program
Program
dimension
Cutting
edge
Workpiece
t2.00
t1.750
Re-
lief
Upper
surface
of table

Z1=1.750

Z5-2.00

Notes:

Unit 28

Introduction

A sample progressive die will be burned out using an automatic move from one station to the next, also using mirror image for one station.

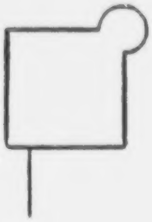
Objectives

Upon successful completion of this lesson the trainee will be able to:

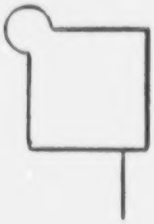
1. Program a progressive die using the Mediapt computer.
2. Manually program a progressive die.
3. Apply mirror image X, Y, or XY to a programmed part.
4. Apply mirror image X, Y, or XY on the machine.
5. Burn out a sample progressive die.
6. Apply proper clearance to die.
7. Apply proper taper to a die.

MIRROR IMAGES

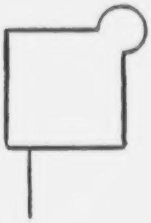
When you are using a mirror image, the shape is flipped on the axis of the mirror image that you are using. For example if you use a Y mirror, the shape is flipped on the Y axis (across the X axis). The NC command is a G62 command, G62X1 —> X mirror on, G62X0Y0 —> XY mirror off.



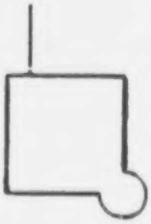
Actual Program



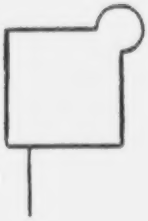
X Mirror



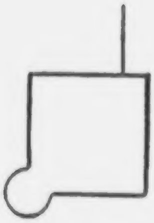
Actual Program



Y Mirror



Actual Program



XY Mirror

MIRROR IMAGE X

X Mirror Image (see Figure 1)

The following steps would be taken to mirror image X.

1. Press the DIS-PLAY and 2 keys to select the USER SETTING screen.

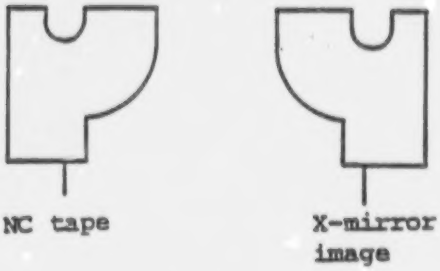


Figure 1

2. Press keys 1, 1, and 1 in data switch group D3.

3. Verify that the <DATA SET> column shows: No. (11) DATA/TIME (1) ( ) ( ), then press the INPUT key.

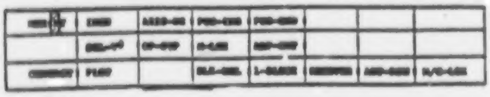
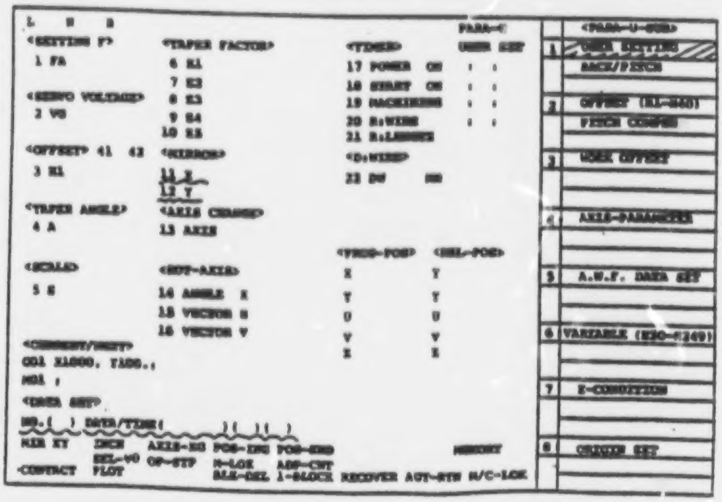


Figure 2.

4. The <MIRROR> column indicates: 11 x 1, and the NC operation status display area is displayed as shown in Figure 2.



```
L  N  S                                                   PARA-U      <PARA-U-SUB>
<SETTING F>     <TAPER FACTOR>       <TIMER>              USER SET  1  USER SETTING
 1 FA            6 K1                17 POWER   ON   :  :              BACK/PITCH
                 7 K2                18 START   ON   :  :
<SERVO VOLTAGE>  8 K3                19 MACHINING    :  :           2  OFFSET (H1-H40)
 2 VO            9 K4                20 R:WIRE       :  :              PITCH COMPEN
                10 K5                21 R:LENGTH
<OFFSET> 41  42 <MIRROR>             <D:WIRE>                       3  WORK OFFSET
 3 H1           11 X                 22 DW        MM
                12 Y
<TAPER ANGLE>   <AXIS CHANGE>                                       4  AXIS-PARAMETER
 4 A            13 AXIS
                                     <PROG-POS>  <REL-POS>
<SCALE>         <ROT-AXIS>           X           Y                  5  A.W.F. DATA SET
 5 S            14 ANGLE  X          Y           Y
                15 VECTOR U          U           U
                16 VECTOR V          V           V                  6  VARIABLE (#30-#249)
<COMMENT/UNIT>                       Z           Z
G01 X1000. Y100.;
M01 ;                                                               7  E-CONDITION
<DATA SET>
NO.(  ) DATA/TIME(        )(  )(  )
MIR XY   INCH    AXIS-XO POS-INC POS-END              MEMORY        8  ORIGIN SET
         SEL-VO  OP-STP  M-LOK   ABS-CNT
CONTACT  PLOT            BLK-DEL 1-BLOCK RECOVER AUT-STN M/C-LOK
```

BEST COPY AVAILABLE

MIRROR IMAGE Y

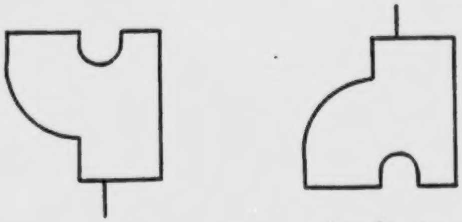


Figure 3.

The following steps would be taken to mirror image Y

1. Press the DIS-PLAY and 2 keys to select the USER SETTING screen.

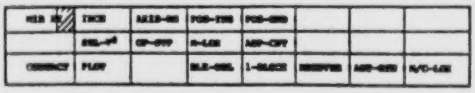
2. Press keys 1, 2, and 1 in data switch group D3.

3. Verify that the <DATA SET> column shows: No. (12) DATA/TIME (1) ( ) ( ), then press the INPUT key.

4. The <MIRROR> column indicates:

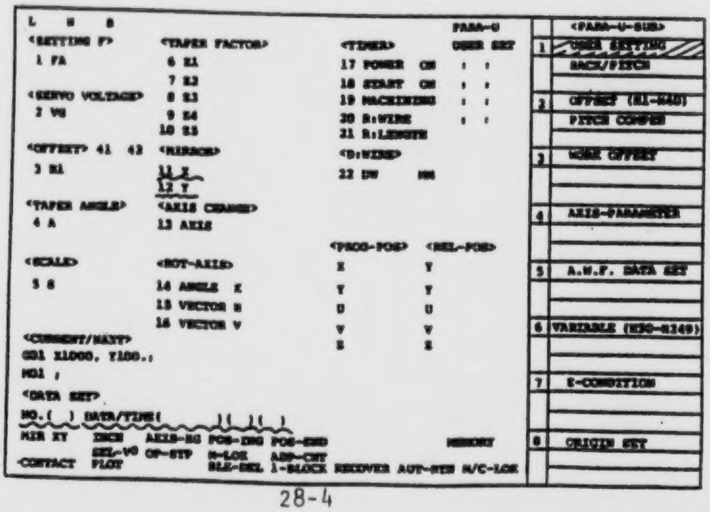
   12 Y 1,

   and the NC operation status display area is displayed as shown in Figure 4.



MIR XY	INCH	AXIS-NG	POS-ING	POS-END			
	SEL-V0	OP-STP	M-LOK	ABS-CNT			
CONTACT	PLOT		BLK-DEL	1-BLOCK	RECOVER	AUT-STB	M/C-LOK

Figure 4



```
L    N    B                                                PARA-U       <PARA-U-SUB>
<SETTING F>      <TAPER FACTOR>      <TIMER>               USER SET   1 USER SETTING
 1 FA             6 E1               17 POWER   ON          :  :        BACK/PITCH
                  7 E2               18 START   ON          :  :
<SERVO VOLTAGE>   8 E3               19 MACHINING           :  :     2 OFFSET (H1-H40)
 2 VG             9 E4               20 R:WIRE              :  :        PITCH COMPEN
                 10 E5               21 R:LENGTH
<OFFSET> 41  42  <MIRROR>            <D:WIRE>                        3 WORK OFFSET
 3 H1            11 X                22 DW       MM
                 12 Y
<TAPER ANGLE>    <AXIS CHANGE>                                       4 AXIS-PARAMETER
 4 A             13 AXIS
                                     <PROG-POS>  <REL-POS>
<SCALE>          <ROT-AXIS>          X           Y                   5 A.W.F. DATA SET
 5 S             14 ANGLE  K         Y           Y
                 15 VECTOR H         U           U
                 16 VECTOR V         V           V                   6 VARIABLE (#00-#249)
<CURRENT/NEXT>                       Z           Z
G01 X1000. Y100.;
M01 ;                                                                7 E-CONDITION
<DATA SET>
NO.(  ) DATA/TIME(        )(   )(   )
MIR XY     INCH    AXIS-NG POS-ING POS-END            MEMORY        8 ORIGIN SET
           SEL-V0  OP-STP  M-LOK   ABS-CNT
<CONTACT   PLOT            BLK-DEL 1-BLOCK RECOVER AUT-STB M/C-LOK
```

BEST COPY AVAILABLE

MIRROR IMAGE X & Y

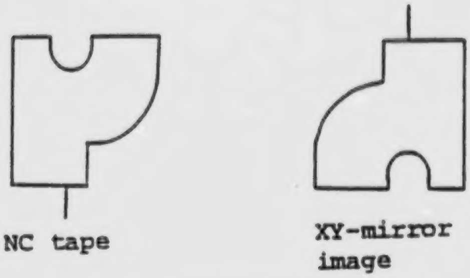


Figure 5.

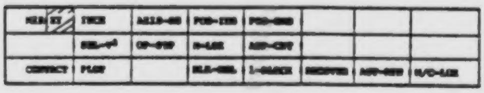


Figure 6

The following steps would be taken to mirror image X & Y

1. Press the $\boxed{\text{DIS-PLAY}}$ and $\boxed{2}$ keys to select the USER SETTING screen. (refer to paragraph 6.3.4 a, X-mirror image.)

2. Press keys $\boxed{1}$, $\boxed{1}$, and $\boxed{1}$ of data switch group D1.

3. Verify that the <DATA SET> column shows:

   No. (11) DATA/TIME (1) ( ) ( ),

   then press the $\boxed{\text{INPUT}}$ key.

4. The <DATA SET> column shows:

   No. (12) DATA/TIME (_) ( ) ( )

   blinking

5. Press the $\boxed{1}$ in data switch group D3.

6. Verify that the <DATA SET> column shows:

   No. (12) DATA/TIME (1) ( ) ( ),

   then press the $\boxed{\text{INPUT}}$ key.

7. The <MIRROR> column indicates:

   11 X 1

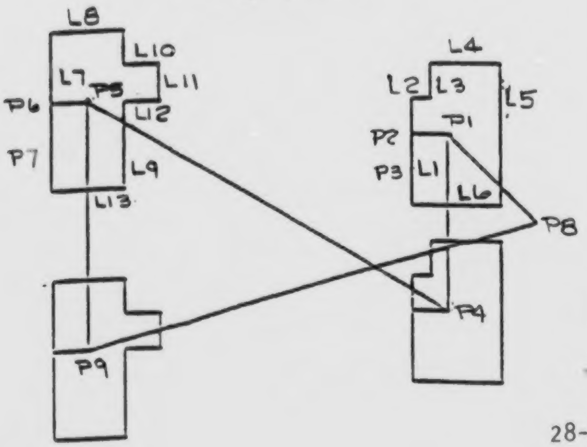
   12 Y 1,

   and the NC operation status display area is displayed as shown in Figure 6.

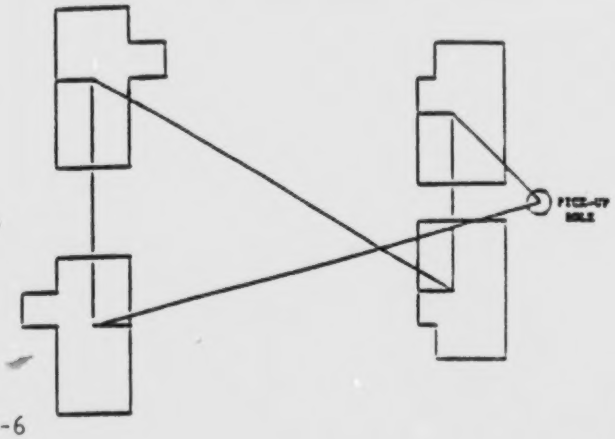
MIRROR IMAGE (G62)

```
P0001=X0.0000/Y0.5000
P0002=X-0.2000/Y0.5000
L0001=P0002/A90.0000
L0002=Y0.7000
L0003=X-0.1000
L0004=Y0.9000
L0005=X0.3000
L0006=Y0.1000
P0004=X0.0000/Y-0.5000
P0005=X-2.0000/Y0.7000
P0006=X-2.2000/Y0.7000
L0007=P0006/A90.0000
L0008=Y1.1000
L0009=X-1.8000
L0010=Y0.9000
L0011=X-1.6000
L0012=Y0.7000
L0013=Y0.2000
P0009=X-2.0000/Y-0.7000
P0008=X0.5000/Y0.0000
INST/G30X-
INST/G90
FROM/P8
INST/F3.;
P0001
STOP
MINR/.01
0001)SET/P1,R
P0002
L0001
L0002
L0003
L0004
L0005
L0006
L0001
P0002
STOP
INST/G40F.2M91;
P0001
STOP
0002)INST/F3.;
P0004
STOP
INST/G62X0Y1
COPY/1,2,N
INST/G62X0Y0
FROM/P4
P0005
STOP
0003)SET/P5,R
INST/F.05M90;
P0006
L0007
L0008
L0009
L0010
L0011
L0012
L0009
L0013
L0007
P0006
STOP
INST/G40F.2M91;
P0005
STOP
0004)INST/F3.;
P0009
INST/G62X1Y0
COPY/3,4,N
INST/G62X0Y0
FROM/P9
P0008
END
MEND
```

MEDIAPT PLOT



MACHINE PLOT



MIRROR IMAGE CANCELLATION

The following steps would be taken to cancel mirror image.

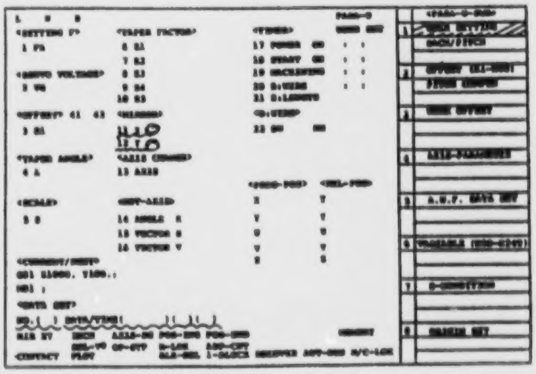
1. Press the $\boxed{\text{DIS-PLAY}}$ and $\boxed{2}$ keys to select the USER SETTING screen. (refer to paragraph 6.3.4 a, X-miror image.)

2. Press keys $\boxed{1}$, $\boxed{1}$, and $\boxed{0}$ in data switch group D3.

3. Verify that the <DATA SET> column shows:

   No. (11) DATA/TIME (0) ( ) ( ),

   then press the $\boxed{\text{INPUT}}$ key.



4. The <DATA SET> column shows:

   No. (12) DATA/TIME ( ) ( ) ( )

   blinking

5. Press the $\boxed{0}$ in data switch group D3.

6. Verify that the <DATA SET> column shows:

   No. (12) DATA/TIME (0) ( ) ( ),

   then press the $\boxed{\text{INPUT}}$ key.

7. The <MIRROR> column indicates:

   11 X 0

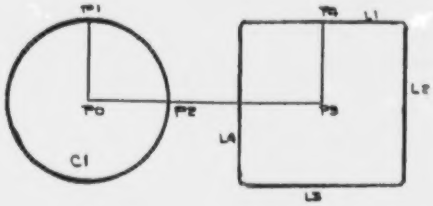
   12 Y 0,

   and the red reversal of MIR XY on the NC operation status display area is cleared.

Note! The mirror image function cannot be turned on or off during program run.

COMPUTER PROGRAMMING A PROGRESSIVE DIE

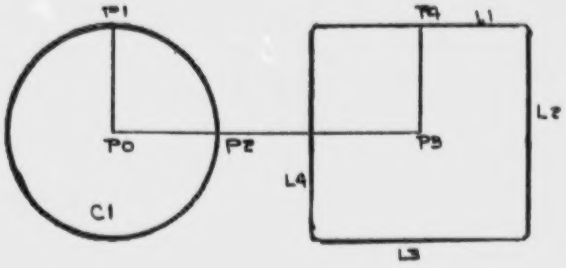
To program a progressive die on the Mediapt, the method shown below describes all your points, lines, and circles.



```
0010        C0001   = P0000         /R      0.3500
0020        P0001   = LY            /C0001     ,U
0030        P0002   = LY            /C0001     ,D
0040        P0003   = X     1.0000  /Y      0.0000
0050        P0004   = X     1.0000  /Y      0.3500
0060        L0001   = Y     0.3500
0070        L0002   = X     1.3500
0080        L0003   = Y    -0.3500
0090        L0004   = X     0.6500
0100        MINR /.020
0110        SET  /P0,R
0120        INST /F500M90 ;
0130        P0001
0140        C0001,CW
0150        P0002             BURN CIRCLE
0160        C0001,CW          STOP AT P1
0170        P0001
0180        STOP
0190        INST /G40F5000M91 ;   MOVE TO P0
0200        P0000                 & STOP
0210        STOP
0220        INST /F50000 ;      MOVE TO P3
0230        P0003               & STOP
0240        STOP
0250        SET  /P3,R
0260        INST /F500M90 ;
0270        P0004
0280        L0001
0290        R0.0000
0300        L0002              BURN OUT
0310        R0.0000            SQUARE & STOP
0320        L0003
0330        R0.0000
0340        L0004
0350        R0.0000
0360        L0001
0370        P0004
0380        STOP
0390        INST /G40F5000M91 ;
0400        P0003
0410        STOP
0420        INST /F50000
0430        P0000
0440        END
0450        MEND
    $
```

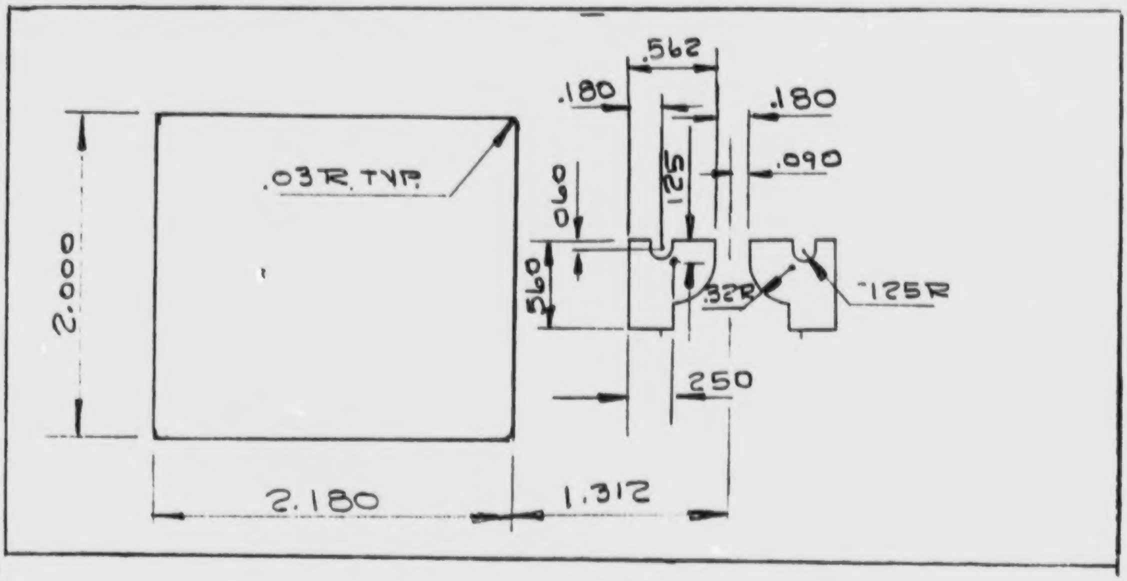
MANUALLY PROGRAMMING A PROGRESSIVE DIE

To manually program a progressive die, use the method shown below.



```
            N0001 M80
            N0002 M82
            N0003 M84
BURN        N0004 G90
CIRCLE      N0005 G92 X         0 Y        0
            N0006 G42 X         0 Y     3500F500M90
            N0007 G02 X         0 Y    -3500 I          0 J      -3500
            N0008 G02 X         0 Y     3500 I          0 J       3500
            N0009 M00

MOVE TO     N0010 G01 X         0 Y        0G40F5000M91
P.O         N0011 M00

MOVE        N0012 G01 X     10000 Y        0F50000
TO P3       N0013 M00

            N0014 M80
            N0015 M82
            N0016 M84
            N0017 G90
BURN        N0018 G92 X     10000 Y        0
SQUARE      N0019 G42 X     10000 Y     3500F500M90
            N0020 G01 X     13300 Y     3500
            N0021 G02 X     13500 Y     3300 I          0 J       -200
            N0022 G01 X     13500 Y    -3300
            N0023 G02 X     13300 Y    -3500 I       -200 J          0
            N0024 G01 X      6700 Y    -3500
            N0025 G02 X      6500 Y    -3300 I          0 J        200
            N0026 G01 X      6500 Y     3300
            N0027 G02 X      6700 Y     3500 I        200 J          0
            N0028 G01 X     10000 Y     3500
            N0029 M00

MOVE TO     N0030 G01 X     10000 Y        0G40F5000M91
P3          N0031 M00

            N0032F50000
            N0033 G01 X         0 Y        0
            N0034 M02
```

Manually or by computer, program the progressive die shown below using mirror image where needed.


.562
.180
.180
.090
125
090
560
.03R. TYP.
.32R
.125R
250
2.000
2.180
1.312

Unit 29

Introduction

An explanation is given of various commands which can be used on the Medi-apt computer.

Objectives

Upon successful completion of this lesson, the trainee will acquire the knowledge of:

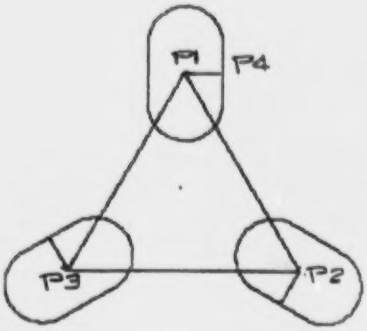
1. The loop and turn command used on the computer.
2. The copy command used on the computer.
3. How to combine the copy command and the loop and turn command.

COPY COMMAND

If your program requires that you burn the same shape in various locations it is only necessary to describe the shape one time in the description. As you are listing the moves in the lower part, you can list these moves once and then give copy command. This type of copy program command is shown below. An explanation of it is given on the following page.

Page shows how long the program would be if it were to be written manually.

```
0010         P0001   = X     0.0000 /Y     0.9800
0020         P0002   = P0000        /R     0.9800     /A  -30.0000
0030         P0004   = X     0.2820 /Y     0.9800
0040         P0003   = P0000        /R     0.9800     /A  210.0000
0050         L0001   = X     0.2820
0060         L0002   = Y     0.4800
0070         L0003   = X    -0.2820
0080         L0004   = Y     1.4800
0090         MINR /.282
0100 0001)   SET  /P1,R
0110         INST /F500M90 ;
0120         P0004
0130         L0001
0140         R0.0000
0150         L0002
0160         R0.0000
0170         L0003
0180         R0.0000
0190         L0004
0200         R0.0000
0210         L0001
0220         P0004
0230         STOP
0240         INST /G40F5000M91 ;
0250         P0001
0260 0002)   STOP
0270         INST /F30000
0280         P0002
0290         STOP
0300         ROT  /A-120,P1
0310         COPY /1,2,N
0320         ROT  /A0,P1
0330         FROM /P2
0340         INST //F30000
0350         P0003
0360         STOP
0370         ROT  /A120,P1
0380         COPY /1,2,N
0390         ROT  /A0,P1
0400         FROM /P3
0410         P0001
0420         END
0430         MEND
```



EXPLANATION OF COPY COMMAND

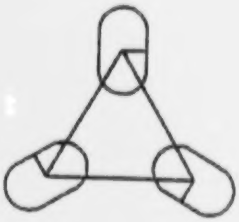
Looking at the program, you will notice that a description of the shape of the opening (note that min R feature is used) [MINR/.282] and that one starting point is given for each of the three openings required (P1,P2,P3). From 0090 to 0260 you have the standard procedure. Starting with 0270 we have:

```
0270 INST/F30000 (RAPID MOVE TO P2)

0280 P2

0290 STOP (stop to rethread wire)

0300 ROT/A-120,P1 (rotate ANGLE 120° from P1)

0310 COPY/1,2,N  copy 1 to 2, these are the numbers just to the
                 left of 0100 and 0260

0320 ROT/A0,P1  Rotate angle of 0° from P1

0330 FROM/P2
```

The same above method would be used to move to point B and burn the last shape.

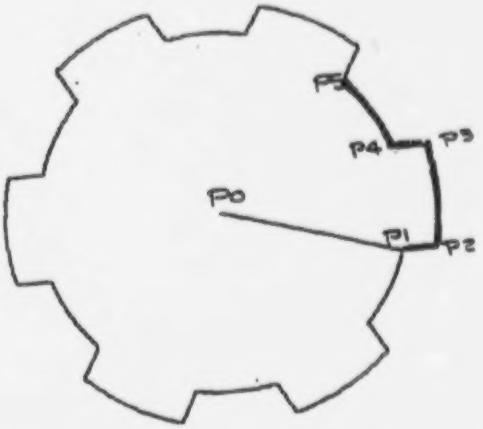
COPY MANUALLY WRITTEN

```
        N0002 M82
        N0003 M84
        N0004 G90
        N0005 G92 X         0 Y       9800
        N0006 G42 X      2820 Y       9800F500M90
        N0007 G01 X      2820 Y       7620
        N0008 G02 X         0 Y       4800 I      -2820 J          0
        N0009 G02 X     -2820 Y       7620 I          0 J       2820
        N0010 G01 X     -2820 Y      11980
        N0011 G02 X         0 Y      14800 I       2820 J          0
        N0012 G02 X      2820 Y      11980 I          0 J      -2820
        N0013 G01 X      2820 Y       9800
        N0014 M00
CUTTING LENGTH =           29 X0.1 INC
        N0015 G01 X         0 Y       9800G40F5000M91
        N0016 M00
CUTTING LENGTH =           32 X0.1 INC
        N0017F30000
        N0018 G01 X      8487 Y      -4900
        N0019 M00
CUTTING LENGTH =           49 X0.1 INC
        N0020 M80
        N0021 M82
        N0022 M84
        N0023 G90
        N0024 G92 X         0 Y       9800
        N0025 G42 X     -1410 Y       7358F500M90
        N0026 G01 X     -3298 Y       8448
        N0027 G02 X     -4330 Y      12300 I       1410 J       2442
        N0028 G02 X      -478 Y      13332 I       2442 J      -1410
        N0029 G01 X      3298 Y      11152
        N0030 G02 X      4330 Y       7300 I      -1410 J      -2442
        N0031 G02 X       478 Y       6268 I      -2442 J       1410
        N0032 G01 X     -1410 Y       7358
        N0033 M00
CUTTING LENGTH =           29 X0.1 INC
        N0034 G01 X         0 Y       9800G40F5000M91
        N0035 M00
CUTTING LENGTH =           32 X0.1 INC
        N0036 G92 X      8487 Y      -4900
        N0037/F30000
        N0038 G01 X     -8487 Y      -4900
        N0039 M00
CUTTING LENGTH =           17 X0.1 INC
        N0040 M80
        N0041 M82
        N0042 M84
        N0043 G90
        N0044 G92 X         0 Y       9800
        N0045 G42 X     -1410 Y      12242F500M90
        N0046 G01 X       478 Y      13332
        N0047 G02 X      4330 Y      12300 I       1410 J      -2442
        N0048 G02 X      3298 Y       8448 I      -2442 J      -1410
        N0049 G01 X      -478 Y       6268
        N0050 G02 X     -4330 Y       7300 I      -1410 J       2442
        N0051 G02 X     -3298 Y      11152 I       2442 J       1410
        N0052 G01 X     -1410 Y      12242
        N0053 M00
CUTTING LENGTH =           29 X0.1 INC
        N0054 G01 X         0 Y       9800G40F5000M91
        N0055 M00
CUTTING LENGTH =           32 X0.1 INC
        N0056 G92 X     -8487 Y      -4900
        N0057 G01 X         0 Y       9800
        N0058 M02
```



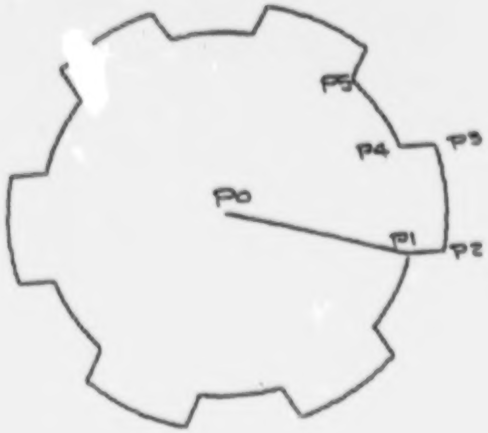
LOOP AND TURN

If you are going to program a spline as shown below, it would not be necessary to program each one of the six splines. It would only be necessary to program one of the six segments (P1-P5) and use a loop command. An explanation is given on the following page. Page shows how long the program would be if it were to be written manually.



```
0010        P0001   = X    0.7068 /Y   -0.2190
0020        P0002   = X    0.8472 /Y   -0.2190
0030        P0003   = X    0.8472 /Y    0.2190
0040        P0004   = X    0.7068 /Y    0.2190
0050        P0005   = X    0.5430 /Y    0.5027
0060        C0001   = X    0.0000 /Y    0.0000    /R    0.8750
0070        C0002   = X    0.0000 /Y    0.0000    /R    0.7400
0080        MINR /.008
0090        SET  /P0.L
0100        INST /F500M90 ;
0110        P0001
0120        LOOP /6,P0
0130        P0002
0140        C0001,CC,R
0150        P0003
0160        P0004
0170        C0002,CC,R
0180        P0005
0190        TURN
0200        STOP
0210        INST /G40F5000M91 ;
0220        P0001
0230        END
0240        MEND
```

LOOP AND TURN MANUALLY WRITTEN



```
MTN.LO
      N0001 M80
      N0002 M82
      N0003 M84
      N0004 G90
      N0005 G92 X          0 Y         0
      N0006 G41 X       7294 Y     -1250F500M90
      N0007 G01 X       8660 Y     -1250
      N0008 G03 X       8660 Y      1250 I      -8660 J        1250
      N0009 G01 X       7294 Y      1250
      N0010 G03 X       4729 Y      5691 I      -7294 J       -1250
      N0011 G01 X       5413 Y      6876
      N0012 G03 X       3248 Y      8126 I      -5413 J       -6876
      N0013 G01 X       2565 Y      6943
      N0014 G03 X      -2564 Y      6942 I      -2565 J       -6943
      N0015 G01 X      -3247 Y      8125
      N0016 G03 X      -5412 Y      6875 I       3247 J       -8125
      N0017 G01 X      -4729 Y      5692
      N0018 G03 X      -7293 Y      1250 I       4729 J       -5692
      N0019 G01 X      -8661 Y      1250
      N0020 G03 X      -8661 Y     -1250 I       8661 J       -1250
      N0021 G01 X      -7295 Y     -1250
      N0022 G03 X      -4730 Y     -5692 I       7295 J        1250
      N0023 G01 X      -5413 Y     -6875
      N0024 G03 X      -3248 Y     -8125 I       5413 J        6875
      N0025 G01 X      -2565 Y     -6942
      N0026 G03 X       2564 Y     -6941 I       2565 J        6942
      N0027 G01 X       3247 Y     -8126
      N0028 G03 X       5413 Y     -6876 I      -3247 J        8126
      N0029 G01 X       4730 Y     -5693
      N0030 G03 X       7294 Y     -1251 I      -4730 J        5693
      N0031 M00
```

EXPLANATION OF LOOP AND TURN COMMAND

Looking at the program, you will notice that 5 points and 2 circles are given; and then just enough information is given so that it can be repeated to complete the shape.

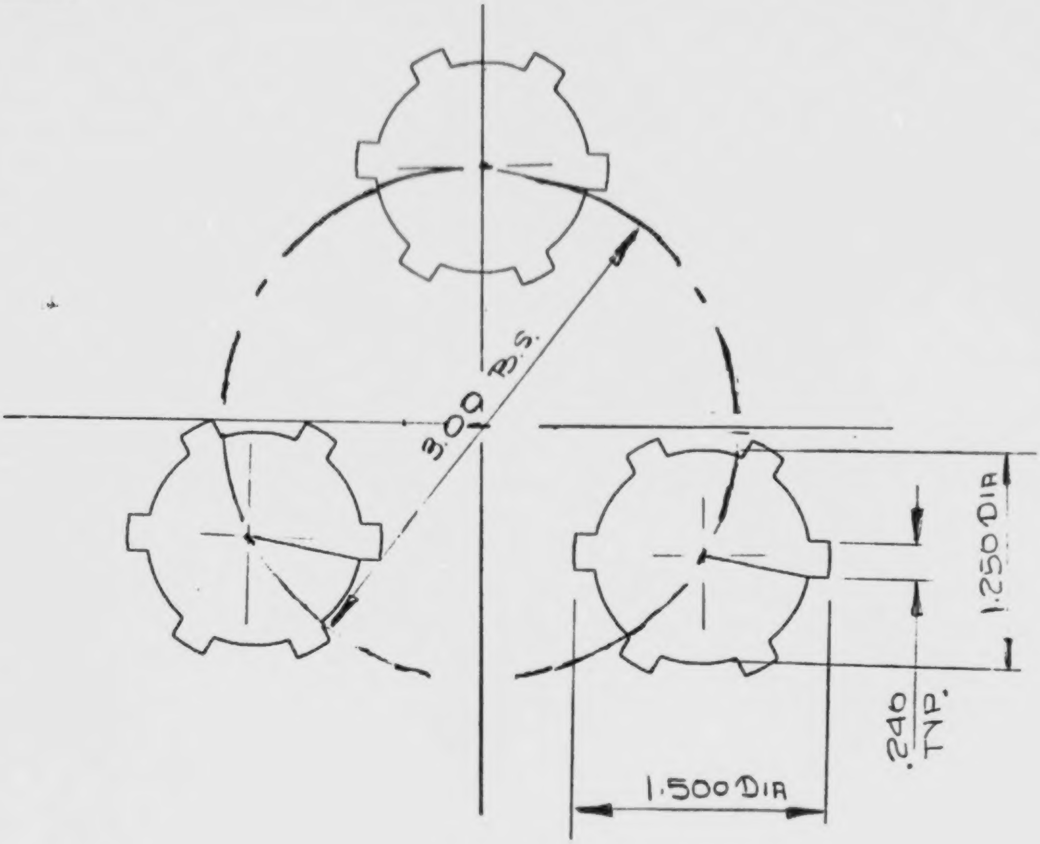
From 0010 to 0110 the program is written the same as any other program.

At 0120, we have a Loop 16,P0 this is telling the computer to loop or repeat the given sahpe 6 times around point "0". The first moves of the shape are then given (0130 - 0180).

At 0190, the word turn is given which tells the computer to go back to 0120 the loop command. This would be repeated 5 times and go onto 0200 the stay move.

COPY AND LOOP AND TURN EXERCISE

Program the part shown below using both copy command and loop and turn command.


3.00 B.S.
1.250 DIA
.240 TYP.
1.500 DIA

Notes:

E Packs

The next five pages will deal with the electrical conditions on the machine. To set these conditions we will use an "E" PACK number which will automaticlly set up the machine for cutting. These electrical conditions will set such items as voltage IP Power, off time, wire speed, wire tension & etc. For a list of these items and a short explanation see page 6 of this series. To use the charts on this page and the next 4 pages, the following steps should be taken:

1. Check material thickness.
2. Look for a chart that will come as close as possible to the thickness of your material. (the material thickness is given at the top of the chart)
3. Look at the chart on the far left #1 on the top part and you will notice there is an E PACK number, on the chart on the left of the page, it is E 516.
4. Enter this number into your machine.
5. This is the starting EP number, once you are into the cut approximately 1/8 inch, you can increase the EP number to the EP number given on Chart 2 (E 529)
6. Enter the new E PACK number into your machine.
7. The other E PACK numbers are for skim cutting which will be covered in a later unit.

Workpiece	Plate Thickness INCH	Wire Electrode
SKD-11	.197	Brass ø0.2

1

No. of Machining Cycles	In-feed
E Pack No.	E516
Voltage Selection VO (Notch)	3
Power Setting	5
OFF Time OFF (Notch)	14
Stabilizing Circuit A SA (Notch)	2
Stabilizing Circuit B SB (Notch)	16
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LS (Notch)	7
Average Machining Voltage VG (V)	55
Stabilizing Circuit C SC (Notch)	1

2

No. of Machining Cycles	1 st
E Pack No.	E529
Voltage Selection VO (Notch)	3
Power Setting	7
OFF Time OFF (Notch)	8
Stabilizing Circuit A SA (Notch)	3
Stabilizing Circuit B SB (Notch)	10
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LS (Notch)	7
Average Machining Voltage VG (V)	44
Stabilizing Circuit C SC (Notch)	1
Set Machining Speed FA (mm/min)	12.0
Offset Amount (µm)	128
Machining Surface Roughness (µm Rmax)	16 to 17

No. of Machining Cycles	1 st	2 nd
E Pack No.	E529	E900
Voltage Selection VO (Notch)	3	3
Power Setting	7	3
OFF Time OFF (Notch)	8	1
Stabilizing Circuit A SA (Notch)	3	-
Stabilizing Circuit B SB (Notch)	10	-
Wire Feeding Speed WS (Notch)	14	14
Wire Tension WT (Notch)	8	11
Pretension PT (Notch)	14	14
Dielectric Fluid Resistivity LS (Notch)	7	7
Average Machining Voltage VG (V)	44	55
Stabilizing Circuit C SC (Notch)	1	1
Set Machining Speed FA (mm/min)	12.0	3.3
Offset Amount (µm)	143	107
Machining Surface Roughness (µm Rmax)	-	5 to 6

No. of Machining Cycles	1 st	2 nd	3 rd
E Pack No.	E529	E900	E915
Voltage Selection VO (Notch)	3	3	4
Power Setting	7	3	3
OFF Time OFF (Notch)	8	1	1
Stabilizing Circuit A SA (Notch)	3	-	-
Stabilizing Circuit B SB (Notch)	10	-	-
Wire Feeding Speed WS (Notch)	14	14	14
Wire Tension WT (Notch)	8	11	11
Pretension PT (Notch)	14	14	14
Dielectric Fluid Resistivity LS (Notch)	7	7	7
Average Machining Voltage VG (V)	44	55	50
Stabilizing Circuit C SC (Notch)	1	1	1
Set Machining Speed FA (mm/min)	12.0	3.3	3.0
Offset Amount (µm)	148	115	100
Machining Surface Roughness (µm Rmax)	-	-	2 to 3

No. of Machining Cycles	1 st	2 nd	3 rd	4 th
E Pack No.				
Voltage Selection VO (Notch)				
Power Setting				
OFF TIME OFF (Notch)				
Stabilizing Circuit A SA (Notch)				
Stabilizing Circuit B SB (Notch)				
Wire Feeding Speed WS (Notch)				
Wire Tension WT (Notch)				
Pretension PT (Notch)				
Dielectric Fluid Resistivity LS (Notch)				
Average Machining Voltage VG (V)				
Stabilizing Circuit C SC (Notch)				
Set Machining Speed FA (mm/min)				
Offset Amount (µm)				
Machining Surface Roughness (µm Rmax)				

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E Packs

Workpiece	Plate Thickness INCH	Wire Electrode
SKD-11	.394	Brass ø0.2

No. of Machining Cycles	In-feed
E Pack No.	E516
Voltage Selection Vo (Notch)	3
Power Setting	5
OFF Time OFF (Notch)	14
Stabilizing Circuit A SA (Notch)	2
Stabilizing Circuit B SB (Notch)	16
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	55
Stabilizing Circuit C SC (Notch)	1

No. of Machining Cycles	1 st
E Pack No.	E530
Voltage Selection Vo (Notch)	3
Power Setting	8
OFF Time OFF (Notch)	9
Stabilizing Circuit A SA (Notch)	3
Stabilizing Circuit B SB (Notch)	8
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	44
Stabilizing Circuit C SC (Notch)	1
Set Machining Speed FA (mm/min)	8.0
Offset Amount (μm)	132
Machining Surface Roughness (μm Rmax)	10 to 19

No. of Machining Cycles	1 st	2 nd
E Pack No.	E530	E901
Voltage Selection Vo (Notch)	3	4
Power Setting	8	4
OFF Time OFF (Notch)	9	14
Stabilizing Circuit A SA (Notch)	3	3
Stabilizing Circuit B SB (Notch)	8	14
Wire Feeding Speed WS (Notch)	14	14
Wire Tension WT (Notch)	8	11
Pretension PT (Notch)	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7
Average Machining Voltage VG (V)	44	50
Stabilizing Circuit C SC (Notch)	1	1
Set Machining Speed FA (mm/min)	8.0	8.0
Offset Amount (μm)	186	186
Machining Surface Roughness (μm Rmax)	-	10 to 12

No. of Machining Cycles	1 st	2 nd	3 rd
E Pack No.	E530	E901	E916
Voltage Selection Vo (Notch)	3	4	5
Power Setting	8	4	3
OFF Time OFF (Notch)	9	14	1
Stabilizing Circuit A SA (Notch)	3	3	-
Stabilizing Circuit B SB (Notch)	8	14	-
Wire Feeding Speed WS (Notch)	14	14	14
Wire Tension WT (Notch)	8	11	11
Pretension PT (Notch)	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7
Average Machining Voltage VG (V)	44	50	50
Stabilizing Circuit C SC (Notch)	1	1	1
Set Machining Speed FA (mm/min)	6.0	6.0	5.0
Offset Amount (μm)	177	117	107
Machining Surface Roughness (μm Rmax)	-	-	3 to 7

No. of Machining Cycles	1 st	2 nd	3 rd	4 th
E Pack No.	E530	E901	E914	E931
Voltage Selection Vo (Notch)	3	4	5	9
Power Setting	8	4	3	2
OFF Time OFF (Notch)	9	14	1	1
Stabilizing Circuit A SA (Notch)	3	3	-	-
Stabilizing Circuit B SB (Notch)	8	14	-	-
Wire Feeding Speed WS (Notch)	14	14	14	14
Wire Tension WT (Notch)	8	11	11	11
Pretension PT (Notch)	14	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7	7
Average Machining Voltage VG (V)	44	50	50	55
Stabilizing Circuit C SC (Notch)	1	1	1	1
Set Machining Speed FA (mm/min)	8.0	8.0	5.3	5.0
Offset Amount (μm)	186	126	114	109
Machining Surface Roughness (μm Rmax)	-	-	-	3 to 4

Workpiece	Plate Thickness INCH	Wire Electrode
SKD-11	.781	Brass ø0.2

No. of Machining Cycles	In-feed
E Pack No.	E516
Voltage Selection Vo (Notch)	3
Power Setting	5
OFF Time OFF (Notch)	14
Stabilizing Circuit A SA (Notch)	2
Stabilizing Circuit B SB (Notch)	16
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	55
Stabilizing Circuit C SC (Notch)	1

No. of Machining Cycles	1 st
E Pack No.	E531
Voltage Selection Vo (Notch)	3
Power Setting	9
OFF Time OFF (Notch)	9
Stabilizing Circuit A SA (Notch)	3
Stabilizing Circuit B SB (Notch)	7
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	44
Stabilizing Circuit C SC (Notch)	1
Set Machining Speed FA (mm/min)	4.0
Offset Amount (μm)	135
Machining Surface Roughness (μm Rmax)	10 to 19

No. of Machining Cycles	1 st	2 nd
E Pack No.	E531	E902
Voltage Selection Vo (Notch)	3	4
Power Setting	9	4
OFF Time OFF (Notch)	9	14
Stabilizing Circuit A SA (Notch)	3	3
Stabilizing Circuit B SB (Notch)	7	14
Wire Feeding Speed WS (Notch)	14	14
Wire Tension WT (Notch)	8	11
Pretension PT (Notch)	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7
Average Machining Voltage VG (V)	44	45
Stabilizing Circuit C SC (Notch)	1	1
Set Machining Speed FA (mm/min)	4.0	4.0
Offset Amount (μm)	167	107
Machining Surface Roughness (μm Rmax)	-	10 to 11

No. of Machining Cycles	1 st	2 nd	3 rd
E Pack No.	E531	E902	E917
Voltage Selection Vo (Notch)	3	4	5
Power Setting	9	4	3
OFF Time OFF (Notch)	9	14	1
Stabilizing Circuit A SA (Notch)	3	3	-
Stabilizing Circuit B SB (Notch)	7	14	-
Wire Feeding Speed WS (Notch)	14	14	14
Wire Tension WT (Notch)	8	11	11
Pretension PT (Notch)	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7
Average Machining Voltage VG (V)	44	45	50
Stabilizing Circuit C SC (Notch)	1	1	1
Set Machining Speed FA (mm/min)	4.0	4.0	5.0
Offset Amount (μm)	103	123	108
Machining Surface Roughness (μm Rmax)	-	-	5 to 7

No. of Machining Cycles	1 st	2 nd	3 rd	4 th
E Pack No.	E531	E902	E917	E932
Voltage Selection Vo (Notch)	3	4	5	12
Power Setting	9	4	3	2
OFF Time OFF (Notch)	9	14	1	1
Stabilizing Circuit A SA (Notch)	3	3	-	-
Stabilizing Circuit B SB (Notch)	7	14	-	-
Wire Feeding Speed WS (Notch)	14	14	14	14
Wire Tension WT (Notch)	8	11	11	11
Pretension PT (Notch)	14	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7	7
Average Machining Voltage VG (V)	44	45	50	50
Stabilizing Circuit C SC (Notch)	1	1	1	1
Set Machining Speed FA (mm/min)	4.0	4.0	5.0	5.0
Offset Amount (μm)	108	128	113	118
Machining Surface Roughness (μm Rmax)	-	-	-	2 to 6

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E Packs

Workpiece	Plate Thickness INCH	Wire Electrode
SKD-11	1.180	Brass ø0.2

No. of Machining Cycles	In-feed
E Pack No.	E517
Voltage Selection Vo (Notch)	3
Power Setting	5
OFF Time OFF (Notch)	14
Stabilizing Circuit A SA (Notch)	2
Stabilizing Circuit B SB (Notch)	16
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	55
Stabilizing Circuit C SC (Notch)	1

No. of Machining Cycles	1 st
E Pack No.	E512
Voltage Selection Vo (Notch)	4
Power Setting	9
OFF Time OFF (Notch)	9
Stabilizing Circuit A SA (Notch)	3
Stabilizing Circuit B SB (Notch)	6
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	44
Stabilizing Circuit C SC (Notch)	1
Set Machining Speed FA (mm/min)	3.3
Offset Amount (μm)	137
Machining Surface Roughness (μm Rmax)	18 to 19

No. of Machining Cycles	1 st	2 nd
E Pack No.	E532	E903
Voltage Selection Vo (Notch)	4	4
Power Setting	9	4
OFF Time OFF (Notch)	9	14
Stabilizing Circuit A SA (Notch)	3	2
Stabilizing Circuit B SB (Notch)	6	14
Wire Feeding Speed WS (Notch)	14	14
Wire Tension WT (Notch)	8	11
Pretension PT (Notch)	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7
Average Machining Voltage VG (V)	44	45
Stabilizing Circuit C SC (Notch)	1	1
Set Machining Speed FA (mm/min)	3.3	4.0
Offset Amount (μm)	167	107
Machining Surface Roughness (μm Rmax)	-	10 to 11

No. of Machining Cycles	1 st	2 nd	3 rd
E Pack No.	E532	E903	E918
Voltage Selection Vo (Notch)	4	4	7
Power Setting	9	4	3
OFF Time OFF (Notch)	9	14	1
Stabilizing Circuit A SA (Notch)	3	2	-
Stabilizing Circuit B SB (Notch)	6	14	-
Wire Feeding Speed WS (Notch)	14	14	14
Wire Tension WT (Notch)	8	11	11
Pretension PT (Notch)	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7
Average Machining Voltage VG (V)	44	45	40
Stabilizing Circuit C SC (Notch)	1	1	2
Set Machining Speed FA (mm/min)	3.3	4.0	4.0
Offset Amount (μm)	181	121	108
Machining Surface Roughness (μm Rmax)	-	-	6 to 7

No. of Machining Cycles	1 st	2 nd	3 rd	4 th
E Pack No.	E532	E903	E918	E933
Voltage Selection Vo (Notch)	4	4	7	9
Power Setting	9	4	3	2
OFF TIME OFF (Notch)	9	14	1	1
Stabilizing Circuit A SA (Notch)	3	2	-	-
Stabilizing Circuit B SB (Notch)	6	14	-	-
Wire Feeding Speed WS (Notch)	14	14	14	14
Wire Tension WT (Notch)	8	11	11	11
Pretension PT (Notch)	14	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7	7
Average Machining Voltage VG (V)	44	45	40	40
Stabilizing Circuit C SC (Notch)	1	1	2	2
Set Machining Speed FA (mm/min)	3.3	4.0	4.0	4.3
Offset Amount (μm)	188	128	113	110
Machining Surface Roughness (μm Rmax)	-	-	-	2 to 4

Workpiece	Plate Thickness INCH	Wire Electrode
SKD-11	1.575	Brass ø0.3

No. of Machining Cycles	In-feed
E Pack No.	E517
Voltage Selection Vo (Notch)	3
Power Setting	5
OFF Time OFF (Notch)	14
Stabilizing Circuit A SA (Notch)	2
Stabilizing Circuit B SB (Notch)	16
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	55
Stabilizing Circuit C SC (Notch)	1

No. of Machining Cycles	1 st
E Pack No.	E533
Voltage Selection Vo (Notch)	4
Power Setting	10
OFF Time OFF (Notch)	9
Stabilizing Circuit A SA (Notch)	3
Stabilizing Circuit B SB (Notch)	6
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	44
Stabilizing Circuit C SC (Notch)	1
Set Machining Speed FA (mm/min)	2.5
Offset Amount (μm)	139
Machining Surface Roughness (μm Rmax)	18 to 19

No. of Machining Cycles	1 st	2 nd
E Pack No.	E533	E904
Voltage Selection Vo (Notch)	4	4
Power Setting	10	44
OFF Time OFF (Notch)	9	12
Stabilizing Circuit A SA (Notch)	3	2
Stabilizing Circuit B SB (Notch)	6	12
Wire Feeding Speed WS (Notch)	14	14
Wire Tension WT (Notch)	8	11
Pretension PT (Notch)	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7
Average Machining Voltage VG (V)	44	45
Stabilizing Circuit C SC (Notch)	1	1
Set Machining Speed FA (mm/min)	2.5	4.0
Offset Amount (μm)	188	109
Machining Surface Roughness (μm Rmax)	-	10 to 11

No. of Machining Cycles	1 st	2 nd	3 rd
E Pack No.	E533	E904	E919
Voltage Selection Vo (Notch)	4	4	8
Power Setting	10	4	3
OFF Time OFF (Notch)	9	12	1
Stabilizing Circuit A SA (Notch)	3	2	-
Stabilizing Circuit B SB (Notch)	6	12	-
Wire Feeding Speed WS (Notch)	14	14	14
Wire Tension WT (Notch)	8	11	11
Pretension PT (Notch)	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7
Average Machining Voltage VG (V)	44	45	40
Stabilizing Circuit C SC (Notch)	1	1	2
Set Machining Speed FA (mm/min)	2.5	4.0	4.0
Offset Amount (μm)	188	128	108
Machining Surface Roughness (μm Rmax)	-	-	6 to 7

No. of Machining Cycles	1 st	2 nd	3 rd	4 th
E Pack No.	E533	E904	E919	E934
Voltage Selection Vo (Notch)	4	4	8	10
Power Setting	10	4	3	2
OFF TIME OFF (Notch)	9	12	1	1
Stabilizing Circuit A SA (Notch)	3	2	-	-
Stabilizing Circuit B SB (Notch)	6	12	-	-
Wire Feeding Speed WS (Notch)	14	14	14	14
Wire Tension WT (Notch)	8	11	11	11
Pretension PT (Notch)	14	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7	7
Average Machining Voltage VG (V)	44	45	40	35
Stabilizing Circuit C SC (Notch)	1	1	2	2
Set Machining Speed FA (mm/min)	2.5	4.0	4.0	4.0
Offset Amount (μm)	188	128	113	110
Machining Surface Roughness (μm Rmax)	-	-	-	3 to 4

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E Packs

Workpiece	Plate Thickness INCH	Wire Electrode
SKD-11	1.968	Brass ø0.2

No. of Machining Cycles	In-feed
E Pack No.	8517
Voltage Selection Vo (Notch)	3
Power Setting	5
OFF Time OFF (Notch)	14
Stabilizing Circuit A SA (Notch)	2
Stabilizing Circuit B SB (Notch)	16
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	55
Stabilizing Circuit C SC (Notch)	1

No. of Machining Cycles	1 st
E Pack No.	8533
Voltage Selection Vo (Notch)	4
Power Setting	10
OFF Time OFF (Notch)	9
Stabilizing Circuit A SA (Notch)	3
Stabilizing Circuit B SB (Notch)	6
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	44
Stabilizing Circuit C SC (Notch)	1

Set Machining Speed FA (mm/min)	2.0
Offset Amount (um)	139
Machining Surface Roughness (um Rmax)	18 to 19

No. of Machining Cycles	1 st	2 nd
E Pack No.	8533	8905
Voltage Selection Vo (Notch)	4	4
Power Setting	10	4
OFF Time OFF (Notch)	9	12
Stabilizing Circuit A SA (Notch)	3	3
Stabilizing Circuit B SB (Notch)	6	12
Wire Feeding Speed WS (Notch)	14	14
Wire Tension WT (Notch)	8	11
Pretension PT (Notch)	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7
Average Machining Voltage VG (V)	44	42
Stabilizing Circuit C SC (Notch)	1	1

Set Machining Speed FA (mm/min)	2.0	4.0
Offset Amount (um)	169	109
Machining Surface Roughness (um Rmax)	-	10 to 11

No. of Machining Cycles	1 st	2 nd	3 rd
E Pack No.	8533	8905	8920
Voltage Selection Vo (Notch)	4	4	8
Power Setting	10	4	3
OFF Time OFF (Notch)	9	12	1
Stabilizing Circuit A SA (Notch)	3	2	-
Stabilizing Circuit B SB (Notch)	6	12	-
Wire Feeding Speed WS (Notch)	14	14	14
Wire Tension WT (Notch)	8	11	11
Pretension PT (Notch)	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7
Average Machining Voltage VG (V)	44	42	40
Stabilizing Circuit C SC (Notch)	1	1	2

Set Machining Speed FA (mm/min)	2.0	4.0	3.0
Offset Amount (um)	180	120	108
Machining Surface Roughness (um Rmax)	-	-	6 to 7

No. of Machining Cycles	1 st	2 nd	3 rd	4 th
E Pack No.	8533	8905	8920	8935
Voltage Selection Vo (Notch)	4	4	8	12
Power Setting	10	4	3	2
OFF TIME OFF (Notch)	9	12	1	1
Stabilizing Circuit A SA (Notch)	3	2	-	-
Stabilizing Circuit B SB (Notch)	6	12	-	-
Wire Feeding Speed WS (Notch)	14	14	14	14
Wire Tension WT (Notch)	8	11	11	11
Pretension PT (Notch)	14	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7	7
Average Machining Voltage VG (V)	44	42	40	35
Stabilizing Circuit C SC (Notch)	1	1	2	2

Set Machining Speed FA (mm/min)	2.0	4.0	3.0	3.0
Offset Amount (um)	188	128	113	110
Machining Surface Roughness (um Rmax)	-	-	-	3 to 4

-4-

Workpiece	Plate Thickness INCH	Wire Electrode
SKD-11	2662	Brass ø0.2

No. of Machining Cycles	In-feed
E Pack No.	8517
Voltage Selection Vo (Notch)	3
Power Setting	5
OFF Time OFF (Notch)	14
Stabilizing Circuit A SA (Notch)	2
Stabilizing Circuit B SB (Notch)	16
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	55
Stabilizing Circuit C SC (Notch)	1

No. of Machining Cycles	1 st
E Pack No.	8533
Voltage Selection Vo (Notch)	4
Power Setting	10
OFF Time OFF (Notch)	9
Stabilizing Circuit A SA (Notch)	3
Stabilizing Circuit B SB (Notch)	6
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	44
Stabilizing Circuit C SC (Notch)	1

Set Machining Speed FA (mm/min)	1.6
Offset Amount (um)	148
Machining Surface Roughness (um Rmax)	18 to 19

No. of Machining Cycles	1 st	2 nd
E Pack No.	8533	8906
Voltage Selection Vo (Notch)	4	4
Power Setting	10	4
OFF Time OFF (Notch)	9	12
Stabilizing Circuit A SA (Notch)	3	2
Stabilizing Circuit B SB (Notch)	6	12
Wire Feeding Speed WS (Notch)	14	14
Wire Tension WT (Notch)	8	11
Pretension PT (Notch)	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7
Average Machining Voltage VG (V)	44	42
Stabilizing Circuit C SC (Notch)	1	1

Set Machining Speed FA (mm/min)	1.6	3.0
Offset Amount (um)	109	109
Machining Surface Roughness (um Rmax)	-	10 to 11

No. of Machining Cycles	1 st	2 nd	3 rd
E Pack No.	8533	8906	8921
Voltage Selection Vo (Notch)	4	4	8
Power Setting	10	4	3
OFF Time OFF (Notch)	9	12	1
Stabilizing Circuit A SA (Notch)	3	2	-
Stabilizing Circuit B SB (Notch)	6	12	-
Wire Feeding Speed WS (Notch)	14	14	14
Wire Tension WT (Notch)	8	11	11
Pretension PT (Notch)	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7
Average Machining Voltage VG (V)	44	42	40
Stabilizing Circuit C SC (Notch)	1	1	2

Set Machining Speed FA (mm/min)	1.6	3.0	3.0
Offset Amount (um)	103	123	110
Machining Surface Roughness (um Rmax)	-	-	5 to 7

No. of Machining Cycles	1 st	2 nd	3 rd	4 th
E Pack No.	8533	8906	8921	8936
Voltage Selection Vo (Notch)	4	4	8	12
Power Setting	10	4	3	2
OFF TIME OFF (Notch)	9	12	1	1
Stabilizing Circuit A SA (Notch)	3	2	-	-
Stabilizing Circuit B SB (Notch)	6	12	-	-
Wire Feeding Speed WS (Notch)	14	14	14	14
Wire Tension WT (Notch)	8	11	11	11
Pretension PT (Notch)	14	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7	7
Average Machining Voltage VG (V)	44	42	40	35
Stabilizing Circuit C SC (Notch)	1	1	2	2

Set Machining Speed FA (mm/min)	2.0	4.0	3.0	3.0
Offset Amount (um)	188	128	115	110
Machining Surface Roughness (um Rmax)	-	-	-	3 to 4

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E Packs

Workpiece	Plate Thickness INCH	Wire Electrode
SKD-11	3 540	Brass φ0.2

No. of Machining Cycles	In-feed
E Pack No.	E517
Voltage Selection Vo (Notch)	4
Power Setting	5
OFF Time OFF (Notch)	14
Stabilizing Circuit A SA (Notch)	2
Stabilizing Circuit B SB (Notch)	16
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	55
Stabilizing Circuit C SC (Notch)	1

No. of Machining Cycles	1 st
E Pack No.	E536
Voltage Selection Vo (Notch)	6
Power Setting	10
OFF Time OFF (Notch)	9
Stabilizing Circuit A SA (Notch)	3
Stabilizing Circuit B SB (Notch)	7
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	49
Stabilizing Circuit C SC (Notch)	1
Set Machining Speed FA (mm/min)	1.0
Offset Amount (μm)	182
Machining Surface Roughness (μm Rmax)	18 to 19

No. of Machining Cycles	1 st	2 nd
E Pack No.	E536	E909
Voltage Selection Vo (Notch)	6	6
Power Setting	10	4
OFF Time OFF (Notch)	9	9
Stabilizing Circuit A SA (Notch)	3	2
Stabilizing Circuit B SB (Notch)	7	9
Wire Feeding Speed WS (Notch)	14	14
Wire Tension WT (Notch)	8	11
Pretension PT (Notch)	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7
Average Machining Voltage VG (V)	49	35
Stabilizing Circuit C SC (Notch)	1	1
Set Machining Speed FA (mm/min)	1.3	4.0
Offset Amount (μm)	177	112
Machining Surface Roughness (μm Rmax)	-	10 to 12

No. of Machining Cycles	1 st	2 nd	3 rd
E Pack No.	E536	E909	E924
Voltage Selection Vo (Notch)	6	6	12
Power Setting	10	4	3
OFF Time OFF (Notch)	9	9	1
Stabilizing Circuit A SA (Notch)	3	2	-
Stabilizing Circuit B SB (Notch)	7	9	-
Wire Feeding Speed WS (Notch)	14	14	14
Wire Tension WT (Notch)	8	11	11
Pretension PT (Notch)	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7
Average Machining Voltage VG (V)	49	35	35
Stabilizing Circuit C SC (Notch)	1	1	2
Set Machining Speed FA (mm/min)	1.0	4.3	3.0
Offset Amount (μm)	182	117	113
Machining Surface Roughness (μm Rmax)	-	-	5 to 7

No. of Machining Cycles	1 st	2 nd	3 rd	4 th
E Pack No.				
Voltage Selection Vo (Notch)				
Power Setting				
OFF TIME OFF (Notch)				
Stabilizing Circuit A SA (Notch)				
Stabilizing Circuit B SB (Notch)				
Wire Feeding Speed WS (Notch)				
Wire Tension WT (Notch)				
Pretension PT (Notch)				
Dielectric Fluid Resistivity LR (Notch)				
Average Machining Voltage VG (V)				
Stabilizing Circuit C SC (Notch)				
Set Machining Speed FA (mm/min)				
Offset Amount (μm)				
Machining Surface Roughness (μm Rmax)	-	-	-	

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Workpiece	Plate Thickness INCH	Wire Electrode
SKD-11	3.940	Brass φ0.2

No. of Machining Cycles	In-feed
E Pack No.	E517
Voltage Selection Vo (Notch)	4
Power Setting	5
OFF Time OFF (Notch)	14
Stabilizing Circuit A SA (Notch)	2
Stabilizing Circuit B SB (Notch)	16
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	55
Stabilizing Circuit C SC (Notch)	1

No. of Machining Cycles	1 st
E Pack No.	E537
Voltage Selection Vo (Notch)	6
Power Setting	10
OFF Time OFF (Notch)	9
Stabilizing Circuit A SA (Notch)	3
Stabilizing Circuit B SB (Notch)	8
Wire Feeding Speed WS (Notch)	14
Wire Tension WT (Notch)	8
Pretension PT (Notch)	14
Dielectric Fluid Resistivity LR (Notch)	7
Average Machining Voltage VG (V)	49
Stabilizing Circuit C SC (Notch)	1
Set Machining Speed FA (mm/min)	0.9
Offset Amount (μm)	153
Machining Surface Roughness (μm Rmax)	18 to 19

No. of Machining Cycles	1 st	2 nd
E Pack No.	E537	E910
Voltage Selection Vo (Notch)	6	8
Power Setting	10	4
OFF Time OFF (Notch)	9	9
Stabilizing Circuit A SA (Notch)	3	2
Stabilizing Circuit B SB (Notch)	8	9
Wire Feeding Speed WS (Notch)	14	14
Wire Tension WT (Notch)	8	11
Pretension PT (Notch)	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7
Average Machining Voltage VG (V)	49	35
Stabilizing Circuit C SC (Notch)	1	1
Set Machining Speed FA (mm/min)	0.9	3.0
Offset Amount (μm)	177	112
Machining Surface Roughness (μm Rmax)	-	10 to 12

No. of Machining Cycles	1 st	2 nd	3 rd
E Pack No.	E537	E910	E925
Voltage Selection Vo (Notch)	6	8	12
Power Setting	10	4	3
OFF Time OFF (Notch)	9	9	1
Stabilizing Circuit A SA (Notch)	3	2	-
Stabilizing Circuit B SB (Notch)	8	9	-
Wire Feeding Speed WS (Notch)	14	14	14
Wire Tension WT (Notch)	8	11	11
Pretension PT (Notch)	14	14	14
Dielectric Fluid Resistivity LR (Notch)	7	7	7
Average Machining Voltage VG (V)	49	35	35
Stabilizing Circuit C SC (Notch)	1	1	2
Set Machining Speed FA (mm/min)	0.9	3.0	3.0
Offset Amount (μm)	182	117	114
Machining Surface Roughness (μm Rmax)	-	-	5 to 7

No. of Machining Cycles	1 st	2 nd	3 rd	4 th
E Pack No.				
Voltage Selection Vo (Notch)				
Power Setting				
OFF TIME OFF (Notch)				
Stabilizing Circuit A SA (Notch)				
Stabilizing Circuit B SB (Notch)				
Wire Feeding Speed WS (Notch)				
Wire Tension WT (Notch)				
Pretension PT (Notch)				
Dielectric Fluid Resistivity LR (Notch)				
Average Machining Voltage VG (V)				
Stabilizing Circuit C SC (Notch)				
Set Machining Speed FA (mm/min)				
Offset Amount (μm)				
Machining Surface Roughness (μm Rmax)				

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E Packs

Electrical Condition	Changeable Notch	Description
Voltage Selection Vo (Notch)	1 - 16	Switch to select the voltage between electrodes when no load is applied. Voltage is higher for larger numbers.
Power Setting Ip (Notch)	1 - 16	Switch to select the peak current level between electrodes. Current is larger for larger numbers.
OFF Time OFF (Notch)	1 - 16	Switch to select interval from finish of discharge to reapplication of voltage. OFF time is shorter and machining speed is faster for smaller numbers.
Stabilizing Circuit A SA (Notch)	1 - 6	Switch to make machining stabler. Speed increases for larger numbers. Wire breaks if the number is too large.
Stabilizing Circuit B SB (Notch)	1 - 16	Switch to stabilize machining as in A. Wire is cut less frequently for larger numbers.
Wire Feeding Switch WS (Notch)	1 - 16	Switch to adjust wire feeding speed. Speed increases for larger numbers.
Wire Tension MT (Notch)	1 - 16	Switch to adjust wire tension (main tension). Tension increases for larger numbers.
Pretension PT (Notch)	1 - 16	Switch to adjust wire tension (Pretension). Tension increases for larger numbers.
Dielectric Fluid Resistivity LR (Notch)	1 - 16	Switch to adjust the dielectric fluid resistivity. Resistivity decreases for larger numbers.
Average Machining Voltage VG (V)	1 - 150	Switch to set average machining voltage to use as a target value in optimal feeding. The range is between 1 and 150 V.
Stabilizing Circuit C SC (Notch)	1 - 3	Switch to stabilize finishing machining. Three switches, 1 to 3, can be selected.

- Fluid injected from upper nozzle does not cover the wire completely.

SYMPTOM	CAUSES	REMEDY
1. The wire breaks suddenly above the workpiece.	1. Aerial discharge occurs because the wire is not fully covered with water.	1. Adjust the clearance between the workpiece surface and nozzle to .004, as shown in Figure 1.
2. Discharge noise changes.		

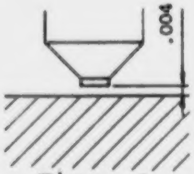


Figure 1

- Lower-fluid flow improper (including power feeding dies)

SYMPTOM	CAUSE	REMEDY
1. The wire breaks suddenly below the workpiece.	1. Lower-fluid flow is injected obliquely.	1. Keep lower-fluid flow in layers.
	2. Lower-fluid flow varies greatly. (Fluid is not injected to the wire properly.)	2. Replace the power feeding dies or adjust the position.
	3. Lower-fluid flow is heavy, resulting in bubbles.	3. Clean the cooling horizontal hole of the diamond dies.
	4. The power feeding dies wear heavily.	
	5. The cooling horizontal hole of the diamond dies is clogged with sludge.	

SYMPTOM	CAUSE	REMEDY
1. The wire breaks immediately after machining is switched on.	1. The energy supply is too great for machining thickness.	1. Alter the machining conditions (power setting, stabilizing circuits A and B) or machining speed F.
2. The wire breaks frequently during operation.	2. The machining condition (power supply) is not suitable for the machining speed (table feed).	2. Operate under adaptive control.

B. Fluid Injection Improper

- Wear in upper power feeding dies

SYMPTOM	CAUSE	REMEDY
1. The wire breaks at the power feeding dies.	1. Aerial discharge may occur between the power feeding dies and wire.	1. Do not turn on the machining switch until bubbles are completely eliminated.
	2. Copper powder attaches to the power feeding dies.	2. Replace the power feeding dies or adjust the position.
	3. The power feeding dies are damaged. (The wire sticks to the power feeding plate.)	3. Clean the cooling horizontal hole of the diamond dies.
	4. The power feeding dies are mounted improperly (improper angle and pressure on wire).	
	5. The cooling horizontal hole of the diamond dies is clogged with sludge.	

C. Wire Tension Change

SYMPTOM	CAUSE	REMEDY
1. The wire breaks frequently.	1. The guide roller moves back and forth or is eccentric.	1. Touch the wire with a finger to see whether wire tension changes quickly or slowly.
	2. The guide roller is damaged at the wire contacting portion, allowing the wire to contact such damage.	2. Turn the guide roller to check for screw looseness, eccentricity, chips, and flaws.
	3. The lower guide roller is clogged with chips and therefore does not rotate.	3. Check the die guide screws for looseness.
	4. The die guide is not fastened firmly.	4. Adjust screw tightness in each portion so that the wire does not slip.
	5. The wire slips on the electromagnetic brake.	5. The electromagnetic brake or the like is mounted improperly. (contact our distributor.)
	6. The wire slips on the takeup pinch roller because its adjusting screw is loose.	6. Replace defective parts or change their mounting positions for reuse.
	7. Revolution of the wire supply reel is uneven.	
	8. The takeup pinch roller is fastened too tightly. (The wire breaks at the takeup roller). (Adjust to the extent that the wire does not slip).	
	9. The limit switch rod is damaged.	

D. Wire Defective

SYMPTOM	CAUSE	REMEDY
1. The wire visibly vibrates significantly even before machining starts. Alignment is not executable.	1. Defective wire (see Fig. 2)	1. Replace.
	(a) Wound too tightly to be released.	2. Increase the wire speed.
	(b) Twisted	
2. Discharge noise is irregular and the wire breaks frequently when the machining switch is turned on.	(c) Copper powder attached	
	(d) Streak on the surface (see fig. 3).	
	(e) No streak on the wire originally, but a streak or scratch may occur on the wire when it passes through the pulleys and rollers.	
	(f) Thickness improper	

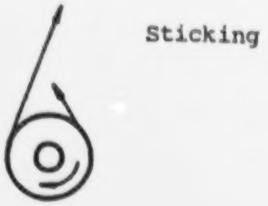


Figure 2

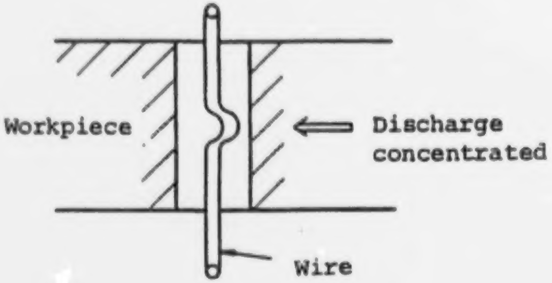


Figure 3

E. Workpiece Material Defective

SYMPTOM	CAUSE	REMEDY
1. Wire breakage occurs for other reasons than listed. The wire breaks although it is used under the same machining conditions as the preceding machining work. 2. Machining accuracy is low, resulting in uneven surface roughness.	1. Material Not Uniform (a) With a workpiece such as stainless steel, the wire may be likely to break at some part of the workpiece because of internal stress or uneven material quality (chromium is not distributed evenly) especially if annealing has not been executed. (b) There are two types of graphite wire: Wire formed in one direction (low quality), and wire formed in all directions (non-directivity). The former is likely to contain cavities and consequently breaks even if the machining speed is slowed. 2. Workpieces Having Residual Magnetism These workpieces may readily cause a short circuit, resulting in wire breakage due to arc discharge, because chips are not removed from their machining grooves.	1. Make sure that workpieces are in good quality and are processed by proper heat treatment. 2. Be sure to eliminate magnetism from workpieces. 3. Change fluid resistivity. 4. Change electrical conditions (lower power setting especially). 5. Slow the wire speed.

Setting Wire Perpendicularity

A. Setting by automatic wire alignment

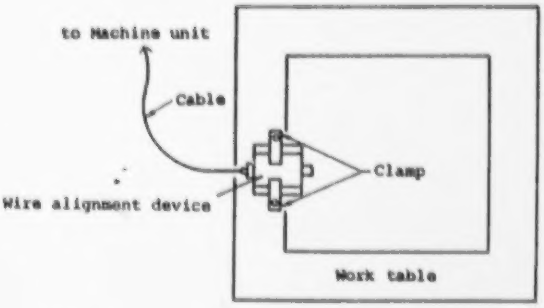

to Machine unit
Cable
Clamp
Wire alignment device
Work table

Figure 1

1. Set a wire alignment device on the work table and connect it to the machine unit with a cable as shown in Figure 1.

2. Press the ○ MANU/AUTO pushbutton

   on the manual box to light the lamp. See Figure 2

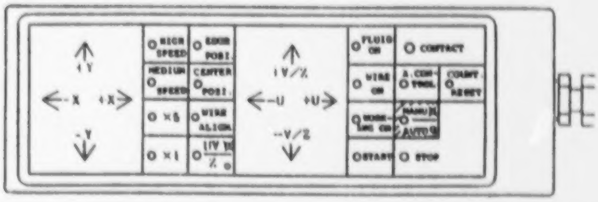

+Y
-X
+X
-Y
HIGH SPEED
EDGE POSI.
MEDIUM SPEED
CENTER POSI.
×5
WIRE ALIGN.
×1
+V/Z
-U
+U
-V/Z
FLUID ON
CONTACT
WIRE ON
COUNT RESET
MANU/AUTO
START
STOP

Figure 2

3. Move the wire toward the wire alignment device with pushbutton [+X], [-X], [+Y], or [-Y] (position A in figure 3)

4. Press the ○ WIRE ALIGN. pushbutton

   on the manual box to light the lamp.

5. Wire feed turns on automatically and the ○ WIRE ON indicator lights.

6. Set the specified wire tension (for example, PT to notch 14 and WT to notch 8 for OB-20P wire). Wire feed speed is determined automatically.

7. Move the wire toward the wire alignment device with pushbutton [+X], [-X], [+Y], or [-Y]. (Press pushbutton [-X] if the wire is at position A of Figure 3)

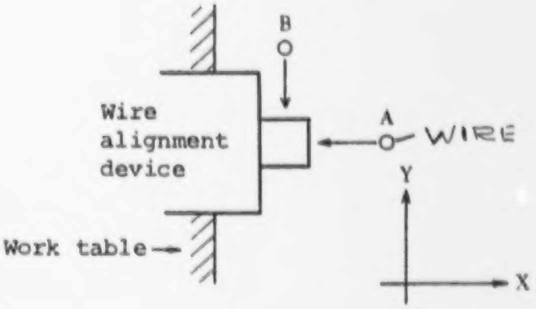

B
A
WIRE
Wire alignment device
Work table
Y
X

figure 3

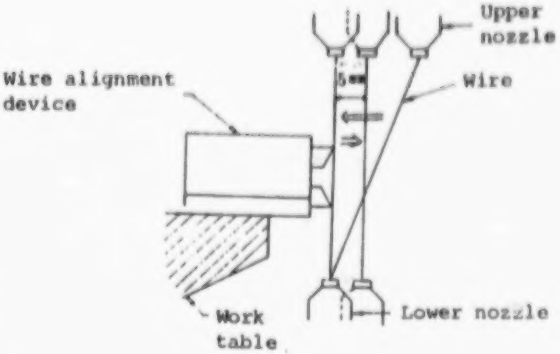

Upper nozzle
Wire alignment device
5mm
Wire
Work table
Lower nozzle

Figure 4

8. The wire moves as shown in Figure 4 and stops .200 from the wire alignment device when it becomes vertical.

   POS-ING in the NC operation status display area is reversed red during this vertical setting and POS-END is reversed red when the setting is complete. (see Figure 5)

9. Press the WIRE ALIGN pushbutton

   on the manual box to turn the lamp off when POS-END is reversed red.

10. Move the wire toward the other axis of the wire alignment device with pushbutton [+X], [-X], [+Y], or [-Y] (position B in Figure 3)

11. Repeat steps (4) to (9) above.

    In step (7), however, press pushbutton [-Y] instead of [-X].

Note!

1. A taper cut device must be provided to use this function.
2. Before using this function, it is better to set the wire as vertical as possible by eye.
3. Place the wire alignment device at a stable position and secure it lightly with a clamp plate on the barycentric line.

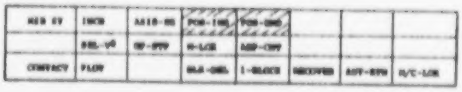

INCH
POS-ING
POS-END
1-BLOCK

Figure 5

B. Setting by manual operation (without taper cut)

1. Execute steps (1) to (3) the preceding paragraph.

2. Press the [-X] pushbutton on the manual box to let the wire contact the measuring surface of the wire alignment device.

3. If only one of the upper and lower indicators lights, move the table along the X axis with the U axis fine adjusting knob (A) until both indicators light simultaneously.

Note! U-axis fine adjusting knob (A) has a lock screw at the rear. Loosen this screw before moving the table and lock it before measuring perpendicularity.

4. Move the wire to postion B of Figure 6.

5. Repeat steps (2) to (3) above for the Y and U axes.

6. Move the wire to position A of Figure 6 again.

7. Repeat steps (2) to (3) above to check perpendicularity.

8. Besure to tighten the lock screws for the U and V axes.

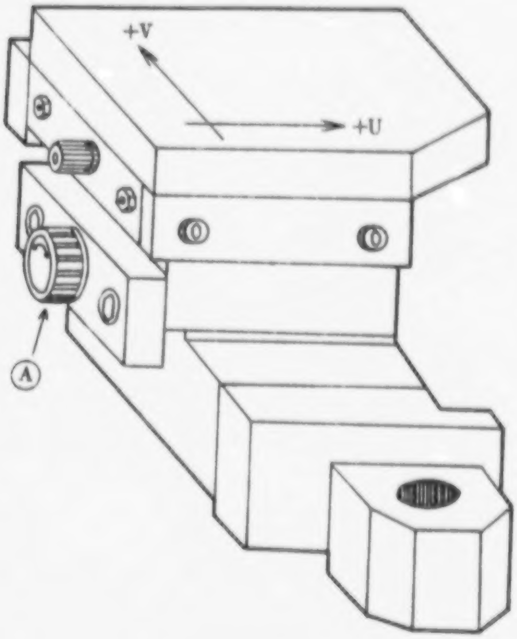


Figure 6

Program Edit (Screen Edit)

Allows you to edit programs registered in the memory by insertion, alteration, and deletion.

OPERATION

A. Screen Selection

1. Press the DIS-PLAY, ALT, and 1 keys in this order.

2. The background color of PROGRAM EDIT is reversed red on the data display area to display the EDIT PROGRAM screen.

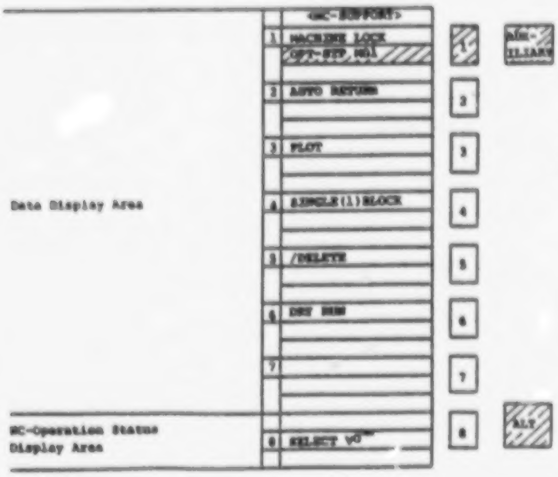
B. Program calling procedure

1. Press the ← or ↑ key to move the cursor into the <DATA SET> column if it is located at the top left corner on the screen.
<DATA SET> L( ) N( ) B( ).

2. Enter a program number, sequence number, and block number in this order by key operation.

To call the head of a program, however, enter only a program number (L number).
<DATA SET> L(program number) N(sequence number) B(block number)

Note! To check the program numbers, comments, etc. of programs registered in the memory, display the MAP screen (press the DIS-PLAY and 8 keys in this order).



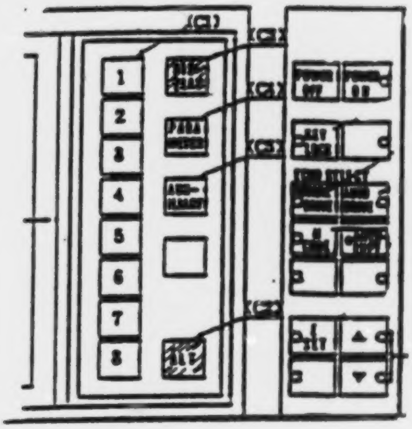
<NC-SUPPORT>
Data Display Area
1 MACHINE LOCK
OPT-STP M01
2 AUTO RETURN
3 PLOT
4 SINGLE(1)BLOCK
5 /DELETE
6 DRY RUN
7
8 SELECT V0
NC-Operation Status
Display Area
1
2
3
4
5
6
7
8
AUX-ILIARY
ALT

3. Press the INPUT key to display programs on the data display area.

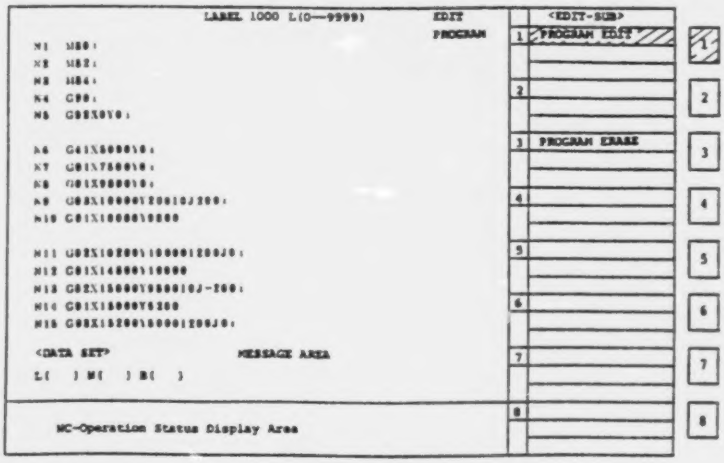
4. Only 15 blocks of programs are displayed on one screen. If there are more, press the NEXT or BACK key to shift each group of five blocks upward or downward so as to display the block required for correction.

Editing a Program on the Machine

To edit a program on the machine the following steps should be taken. (press the following keys)



1. **DIS PLAY** #1
2. **ALT.**
3. Key **#1** (Edit will be highlighted)
4. Program will appear on CRT
5. Cursor down to the right to get to the place you want to change or add information (to move cursor use arrow keys just below insert and delete keys)
6. Make whatever changes are required
7. Push **INPUT** key
8. Plot to be sure change is correct


LABEL 1000 L(0—9999)

EDIT PROGRAM

<EDIT-SUB>

1 PROGRAM EDIT

3 PROGRAM ERASE

<DATA SET>

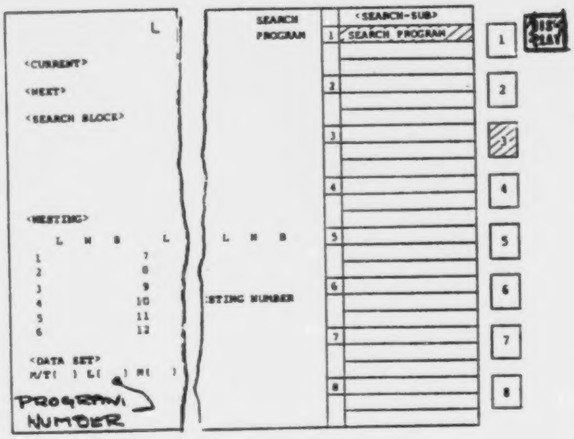
MESSAGE AREA

L( ) M( ) B( )

NC-Operation Status Display Area

To Plot Any Part

The following steps should be taken to plot any part


SEARCH
PROGRAM
<SEARCH-SUB>
1 SEARCH PROGRAM
2
3
4
5
6
7
8
DISPLAY
<CURRENT>
<NEXT>
<SEARCH BLOCK>
<NESTING>
L N B L
1 7
2 8
3 9
4 10
5 11
6 12
<DATA SET>
M/T( ) L( ) N( )
PROGRAM NUMBER
L N B
STING NUMBER

1. Push **DISPLAY** key

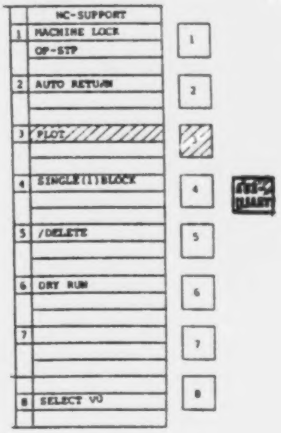
2. Push **#3** key (Search)

3. Enter program number where cursor is flashing

    A. Delete old program if number appears where cursor is flashing. To do this push **RESET** key

    B. Enter **"M"** if program is from memory or **"T"** if from tape

    C. Enter your program number


NC-SUPPORT
1 MACHINE LOCK
OP-STP
2 AUTO RETURN
3 PLOT
4 SINGLE(1)BLOCK
5 /DELETE
6 DRY RUN
7
8 SELECT VU
1
2
3
4
5
6
7
8
AUXILIARY

4. Push **AUXILIARY** key.

5. Push **#3** key **PLOT**. The word plot will now be highlighted both at #3 and also at the lower lefthand corner of CRT

6. Push **START** key either at control panel or manual box

7. Machine will plot but it will be 180° from the way it will actually burn

8. After part is plotted turn **OFF** plot light

    A. Push **AUXILIARY** key

    B. Push **#3 PLOT**

TO ERASE A PROGRAM FROM MEMORY

After you have run your program and do not plan on running it again, it should be erased from the memory of the machine. This is done in the following manner.

1. Push **DISPLAY** key

2. Push **ALT** key

3. Push **#1 EDIT** on CRT

4. Push **#3 PROGRAM ERASE**

5. Cursor will be flashing at lower left of CRT. Enter **#1, 2 or 3**

    #1 is for L #0-7999

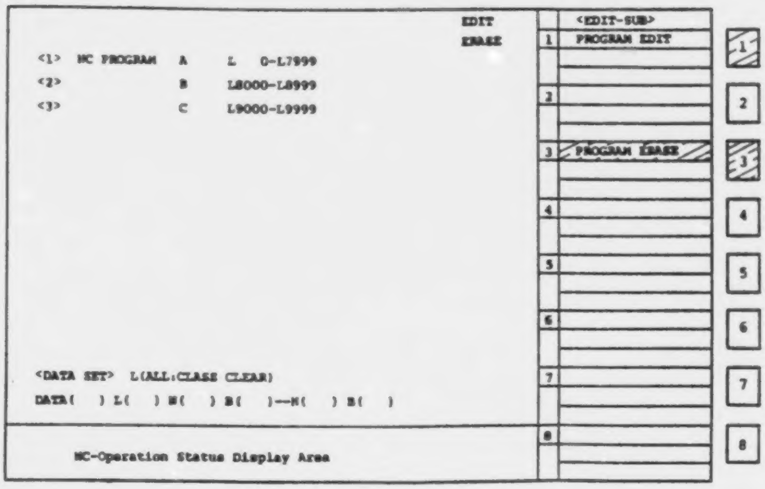
    #2 is for L #8000-8999

    #3 is for L #9000-9999

6. Enter part number you want to delete (do not enter the L)

7. Push **INPUT** key

3 PROGRAM ERASE (DIS-PLAY → ALT → 1 → 3)

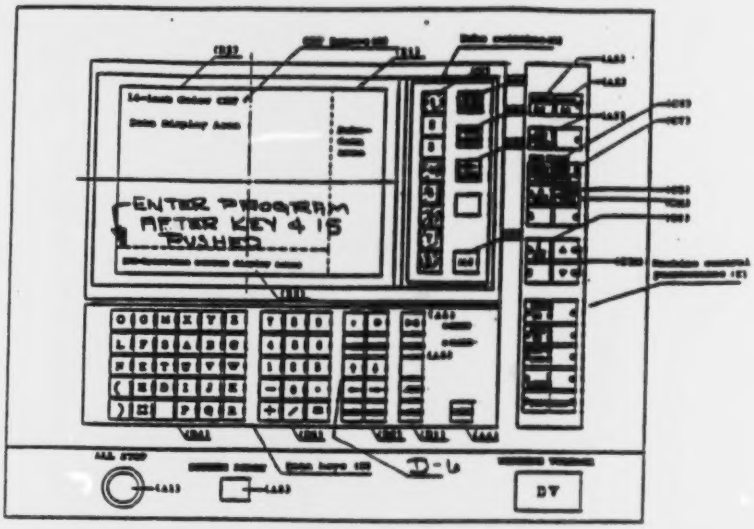


```
                                                  EDIT
                                                  ERASE
<1>  NC PROGRAM   A    L   0-L7999
<2>               B    L8000-L8999
<3>               C    L9000-L9999

<DATA SET>  L(ALL:CLASS CLEAR)
DATA(   ) L(   ) N(   ) B(   )--N(   ) B(   )

     NC-Operation Status Display Area
```

To Display Graphics While Another Part Is Running



To display graphics on a particular part while another part is running, the following steps should be taken:

1. **DISPLAY**
2. **(6) GRAPHICS**
3. **(1) POSITION**
4. **(4) PROGRAM**
    A. Enter part number where cursor is flashing - lower left. **Note!** you may need to push Delete button if number or part of old number remains.
    B. **INPUT** button.
5. **(5) VIEWPOINT**
    A. **#1** on keyboard
6. **(7) FRAME**
    A. ***** key
7. Wait until Auto scaling fin appears (lower right of CRT).
8. **(8) DRAWING START**

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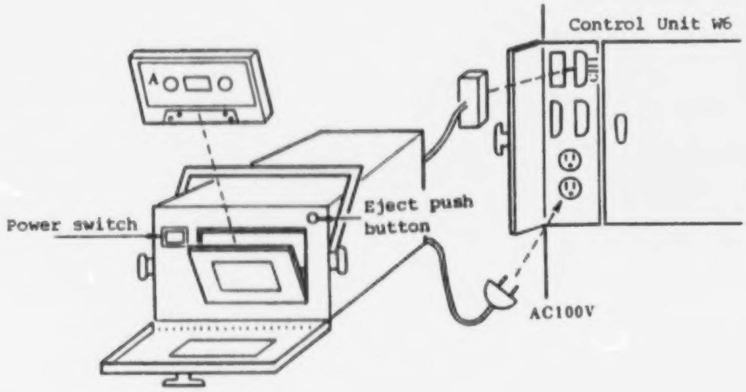
LOADING SOFTWARE

Loading software will erase the E-Pak, so be sure to store it on cassette before loading software.

1. Breaker switch on, Power switch off, Door interlock off.
2. Open front door and remove cover from printed circuit boards.
3. Connect cassette to RS-232C-CH1 and 100V power line to outlet.
4. "ALL STOP" in.
5. Turn power on.
6. Turn C.M.T. device on (Cassette deck)



7. Put cassette #1 into C.M.T. (Ram clear - 130AB)
8. Flip toggle switch on FX-14 down, (Switch stays down)
9. Flip top toggle switch on FX-01 up.
10. Flip bottom toggle switch on FX-01 down (After it clicks, it returns to center position and tape is read). Reading time = 1-2 minutes. Tape automatically rewinds after reading.
11. Put cassette #2 into C.M.T. device. Flip down on bottom switch of FX-01. Tape is read (Reading time = 5-6 mintues)
12. Any additional tapes are loaded the same as step #11. DO NOT LOAD E-PAK TAPE NOW. Load in after the pitch error data below.
13. After tape loading is completed flip toggel switch on FX-14 up. (Switch stays up)
14. Flip top switch on FX-01 down. (Switch stays down)
15. Flip bottom switch on FX-01 down, (After it clicks, switch returns to center position)
16. Wait 4-5 seconds and release "ALL STOP".
17. Press "SYSTEM READY".
18. Press "RESET" (The table will not move until reset is pressed).
19. Replace cover over circuit boards.
20. Close front door and lock it.
21. Press "MANUAL DRIVE". Press SET ZERO U V (Alt. 6). Press U and V.

ENGLISH DISPLAY

1. Press display - 5 - 5.
2. Fill in H (1000) (00000100) M2 INPUT INPUT.
3. Press display - 2 - 1.
4. Fill in No. (24) (0) INPUT.
5. Press display - 5 - 5.
6. Fill in H (00000000) (M2) INPUT INPUT.

INCH DISPLAY

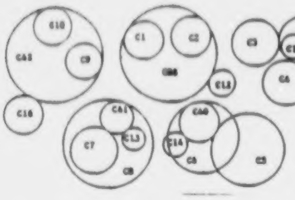
Press #1

1. Press "ALL STOP".
2. Press PARAMETER - INCH (3).
3. Release "ALL STOP".
4. Press "SYSTEM READY ON".

PITCH ERROR

1. Jog machine within 1-2 inches of X(-) and Y(-) corner.
2. Select "MANUAL DRIVE" mode. Press origin (5) on controller.
3. Press X(-) and Y(÷) jog buttons on manual box. The machine will go to its zero point.
4. Take off origin (Press 5).
5. Press Display - Date I/O (7) - Data Input (1).
6. Put tape in tape reader. Enter (3) into data - press input.

MEDIAPT DEFINITIONS (EXERCISE)
POINTS, LINES, CIRCLES


C10
C42
C9
C1
C2
C88
C3
C39
C13
C12
C4
C16
C41
C13
C7
C8
C40
C14
C6
C5

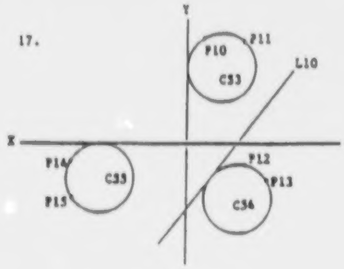
C88:

C39:

C40:

C41:

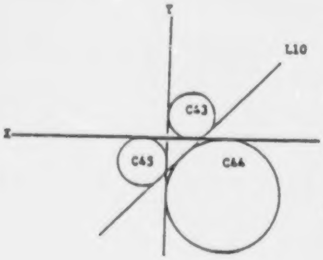
C42:


Y
17.
P10
P11
C53
L10
X
P14
C55
P15
P12
P13
C54

C53:

C54:

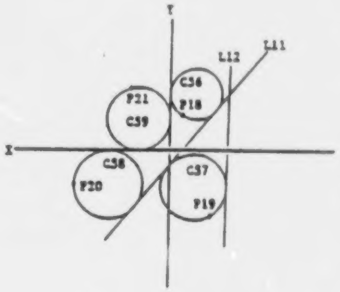
C55:


Y
L10
C43
X
C45
C44

C43:

C44:

C45:

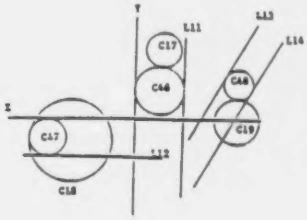

Y
L12
L11
C56
P21
P18
C59
X
C58
C57
P20
P19

C56:

C57:

C58:

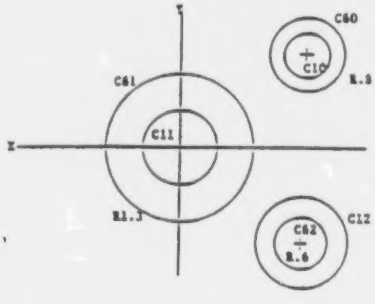
C59:


Y
L11
L13
L14
C17
C46
C48
X
C47
C19
L12
C18

C46:

C47:

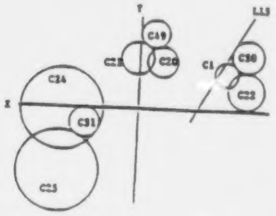
C48;


Y
C60
C10
R.3
C61
X
C11
R1.3
C62
C12
R.6

C60:

C61:

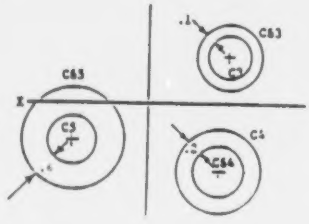
C62:


Y
L13
C19
C21
C20
C1
C30
C24
C22
X
C31
C25

C49:

C50:

C51:

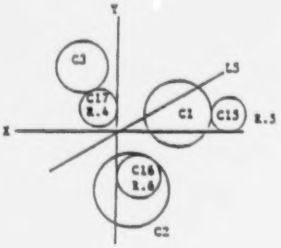

Y
.1
C63
C3
C65
X
C5
.6
C4
.2
C64

C63:

C64:

C65:

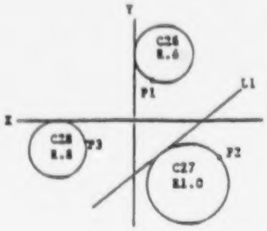
MEDIAPT DEFINITION'S (EXERCISE)
POINTS, LINES, CIRCLES


Y
C3
L5
C17 R.4
C1
C15 R.5
X
C16 R.4
C2

C15:

C16:

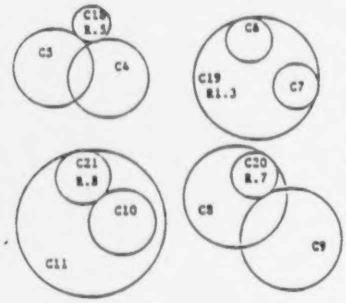
C17:


Y
C26 R.6
P1
L1
X
C28 R.8
P3
P2
C27 R1.0

C26:

C27:

C28:

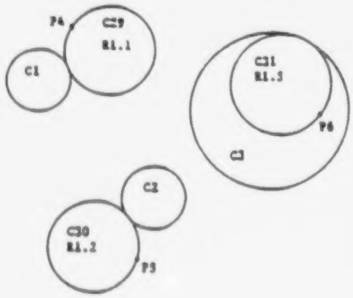

C18 R.5
C5
C4
C6
C19 R1.3
C7
C21 R.8
C10
C11
C20 R.7
C8
C9

C18:

C19:

C20:

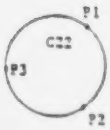
C21:


P4
C29 R1.1
C1
C31 R1.5
P6
C3
C2
C30 R1.2
P5

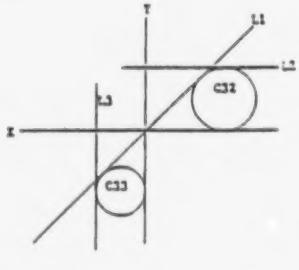
C29:

C30:

C31:

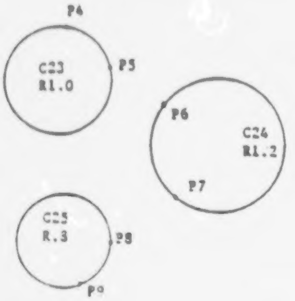


C22:


Y
L1
L2
L3
C32
X
C33

C32:

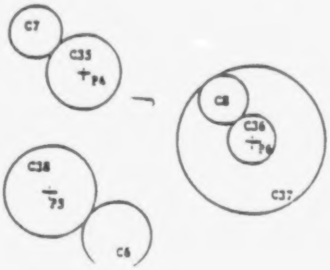
C33:


P4
C23 R1.0
P5
P6
C24 R1.2
P7
C25 R.3
P8
P9

C23:

C24:

C25:


C7
C35 P4
C8
C36 P6
C37
C38 P5
C6

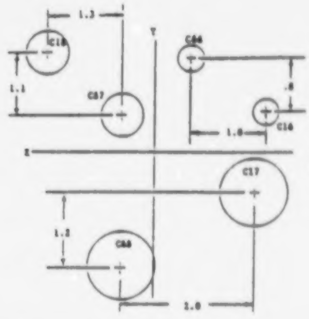
C35:

C36:

C37:

C38:

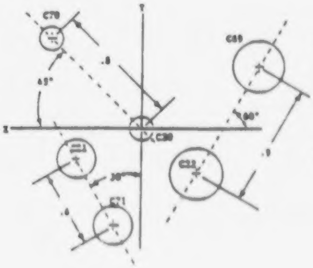
MEDIAPT DEFINITIONS (EXERCISE)
POINTS, LINES, CIRCLES


1.3
C18
1.1
C67
Y
C66
.8
C16
1.0
X
C17
1.2
C68
2.0

C66:

C67:

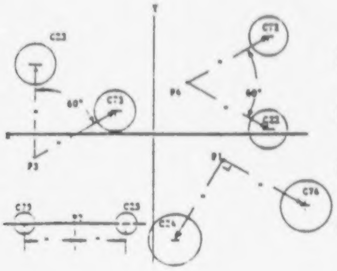
C68:


C70
Y
.8
C69
45°
60°
X
C30
30°
.9
.6
C71

C69:

C70:

C71:


Y
C72
60°
C73
P4
60°
P3
C24

C72:

C73:

C74:

C75:

ANSWER KEY TO MEDIAPT DEFINITION EXERCISE

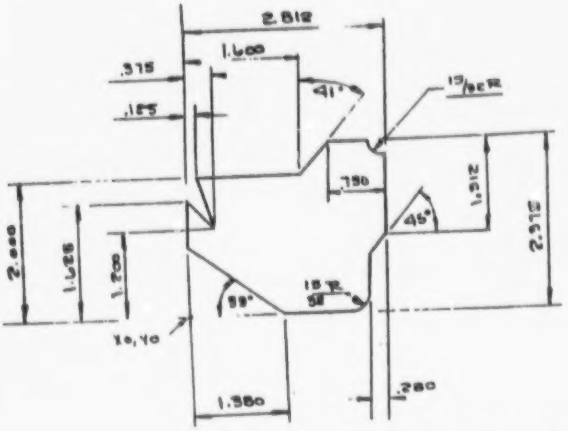
P1:X.9/Y.6
P2:X.3/Y-.7
P3:X-.5/Y0
P4:X-.5/Y.8
P5:P1/X-.6/Y.5
P6:P2/X1.0/Y0
P7:P3/X-.9/Y-.3
P8:P4/X.5/Y.7
P9:L1/LX
P10:L2/L1
P11:LY/L2
P12:L3/LX
P13:LY/L3
P14:L1/C1,U
P15:L2/C1,R
P16:L1/C1,L
P17:L2/C1,L
P19:C1/C2,U
P20:C2/C1,L
P21:C3/C2,D
P22:C3/C2,U
P23:P0/C4,L
P24:P0/C4,D
P26:P25/C5,R
P27:P25/C5,L
P29:P28/LX
P31:P30/L5
P33:P32/LY
P34:P9/R1.2/A60
P35:P0/R2.5/A-80
P36:P0/R1.8/A210
L53:P3/C8,L
L54:P4/P5,N

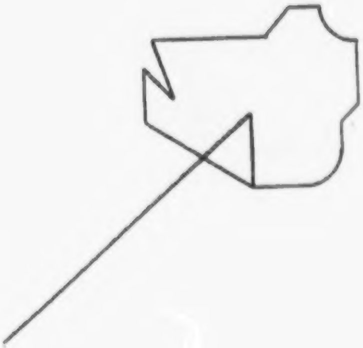
P37:P10/R.9/A135
P44:C1
P45:C3
P46:C2
P48:P47/P1/A225
P50:49/P4/A-80
P52:P51/P3/A180.0
P54:P53/P2/A-140.0
P57:P56/P55
P60:P59/P58
P63:P62/P61
P66:P65/P64,N
P69:P67/P68,N
P72:P70/P71,N
P74:P73/P0/A80/D.6
P76:P75/P74/A-70/D.5
P79:P78/P77/A85/D.7
P82:P81/P80/A80/D1.0
L1:P1/P2
L2:P2/P3
L3:P1/P0
L4:P0/P4
L5:P4/A45
L6:P6/A90
L7:P0/A30
L8:P5/A-45
L9:X.9/Y.5/A90
L10:X.9/Y-.7/A120
L11:X0/Y-.7/A60
L12:X-.8/Y1.0/A-45
L14:P4/L13/A70
C21:C10,0/C11,I,U/R.8
C22:P3/P1/P2

L15:P4/L13/A-30
L17:P3/L6/A90
L19:P2/L18/A-60
L20:P10/LY,P
L21:P11/LX,P
L23:P12/L22,P
L24:P13/LY,N
L25:P14/LX,N
L27:P15/L26,N
L28:LX/P16
L29:LY/P17
L31:L30/P18
L32:LX,U/D.9
L33:L34,U/D.7
L36:L35,L/D.6
L37:LY,L/D.5
L38:C1,U/A45
L39:C2,L/A90
L40:C3,L/A60
L41:C4,U/A30
L42:C6,U/C7,U
L43:C6,U/C5,D
L44:C6,D/C7,D
L45:C6,D/C5,D
L46:Y.8
L47:X-.5
L48:Y-.7
L49:X.6
L50:P1/C9,L
L51:P1/C8,U
L52:P2/C8,R
C53:P10/P11/LY,D
C54:P12/P13/L10,D

```
L55:P6/P7,N
L56:P0/P8,N
L57:LX,U/LY,R
L59:L58,U/LY,L
L61:L60,D/LY,L
L64:L63,U/L62,D
L65:LX/L10
L66:LX/L20
L68:LY/L67
C1:X.8/Y.5/R.4
C2:X-.9/Y.45/R.8
C3:X-1.0/Y-.7/R.3
C4:X4/Y-.6/R.6
C5:P1/R.9
C6:P2/R.5
C7:P0/R1.0
C8:P4/LX
C9:P3/LY
C10:P5/L1
C11:L3,D/LX,U/R.7
C12:LY,L/L3,D/R.9
C13:LY,R/LX,U/R.6
C14:L2,L/LX,U/R1
C15:LX,U/C1,0,R/R.5
C16:LY,R/C2,I,U/R.6
C17:LY,L/C3,0,D/R.4
C18:C5,0/C4,0,U/R.5
C19:C6,I/C7,I,D/R1.3
C20:C8,I/C7,O/R.7
C23:P4/P5,D/R1.0
C24:P6/P7,R/R1.2
C25:P8/P9,L/R.8
C26:P1/LY,U/R.6
C27:P2/L1,D/R1
C28:P3/LX,L/R.8
C29:P4/C1,0,R/R1.1
C30:P5/C2,0,L/R1.2
C31:P6/C3,I,U/R1.5
C32:L2/LX/L1,R
C33:LY/L3/L1,D
C35:P4/C7,S
C36:P6/C8,S
C37:P6/C8,B
C38:P5/C6,S
C88:C1,I/C2,I/C12,0
C39:C13,I/C3,0/C4,0
C40:C6,I/C5,0/C14.0
C41:C15,0/C7,0/C8,I
C42:C16,0/C10,I/C9,I
C43:L10,L/LY,R/LX,U
C44:L10,R/LX,D/LY,R
C45:LY,L/L10,L/LX,D
C46:L11,L/LY,R/C17,0,D
C47:L12,U/LX,D/C18,I,L
C48:L14,L/L13,R/C19,0,U
C49:LY,R/C21,0/C20,0,U
C50:L15,R/C1,0/C22,O,U
C51:LY,D/C24,I/C25,I
C55:P14/P15/LX,R
C56:P18/L11/LY,U
C57:P9/L11/L12,U
C58:P20/LX/L11.R
C59:P21LY/LX,D
C60:C10/R.8
C61:C11/R1.3
C62:C12/R.6
C63:C3,0/D.1
C64:C4,I/D.2
C65:C5,0/D.4
C66:C16/X-1.0/Y.8
C67:C18/X1.3/Y-1.1
C68:C17/X-2.0/Y-1.2
C69:C22/R.9/A60
C70:C20/R.8/A135
C71:C21/R.6/A-60 (OR A300)
C72:C22/P4/A60
C73:C23/P23/A-60
C74:024/P1/A90
C75:C25/P2/A180
C76:C26/P15
C77:C27/P0
C78:C28/P16
C79:C29/L10
C80:C30/L11
C81:C31/LX
```

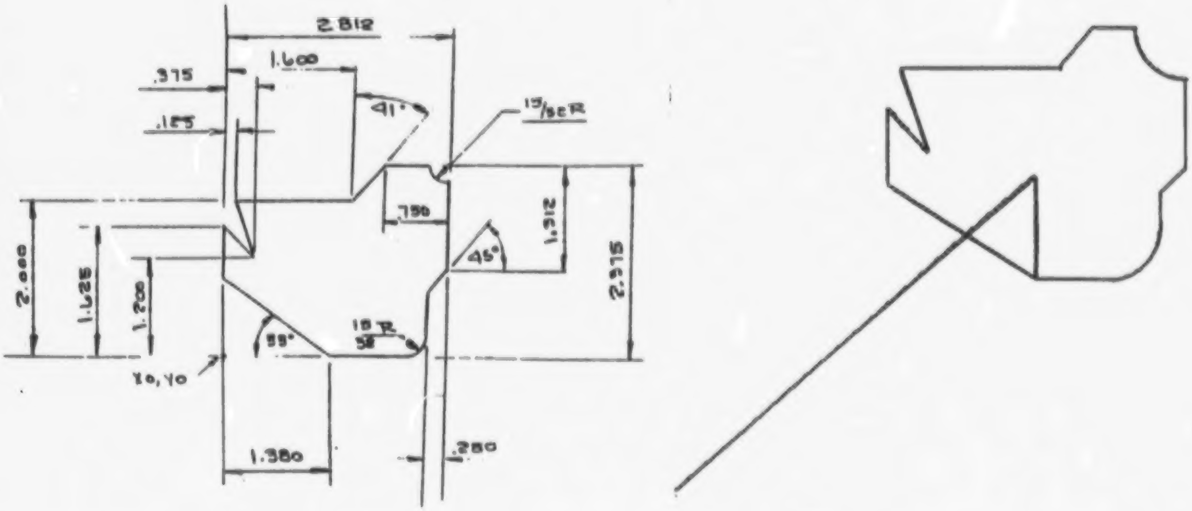
Answer to Computer Program Unit 7





```
0010          P0001   = X     1.3800 /Y     1.0000
0020          L0001   = X     1.3800
0030          P0002   = X     1.3800 /Y     0.0000
0040          L0002   = P0002        /A   147.0000
0050          L0003   = X     0.0000
0060          P0003   = X     0.0000 /Y     1.6250
0070          P0004   = X     0.3750 /Y     1.2000
0080          L0004   = P0003        /P0004
0090          P0005   = X     0.1250 /Y     2.0000
0100          P0010   = X    -2.0000 /Y    -2.0000
0110          L0005   = P00U4        /P0005
0120          L0006   = Y     2.0000
0130          P0006   = X     1.6000 /Y     2.0000
0140          L0007   = P0006        /A    49.0000
0150          L0008   = Y     2.3750
0160          C0001   = X     2.8120 /Y     2.3750    /R     0.4680
0170          L0009   = X     2.8120
0180          P0007   = X     2.8120 /Y     1.0630
0190          L0010   = P0007        /A    45.0000
0200          L0011   = X     2.3620
0210          C0002   = X     2.0940 /Y     0.4680    /R     0.4680
0220          L0012   = Y     0.0000
0230           INST //G90
0240           FROM /P10
0250           P0001
0260           STOP
0270           MINR /.008
0280           SET  /P1,L
0290           INST /F500M90 ;
0300           L0001
0310           L0002
0320           L0003
0330           L0004
0340           L0005
0350           L0006
0360           L0007
0370           L0008
0380           C0001,CC,L
0390           L0009,D
0400           L0010
0410           L0011
0420           C0002,CW
0430           L0012
0440           P0002
0450           STOP
0460           INST /G40F5000M91 ;
0470           P0001
0480           END
0490           MEND
```

Answer to Manual Program Unit 7


2.812
1.600
.375
.125
41°
15/32 R
.750
1.312
45°
2.375
2.000
1.625
1.200
55°
15/32 R
X0,Y0
1.380
.280

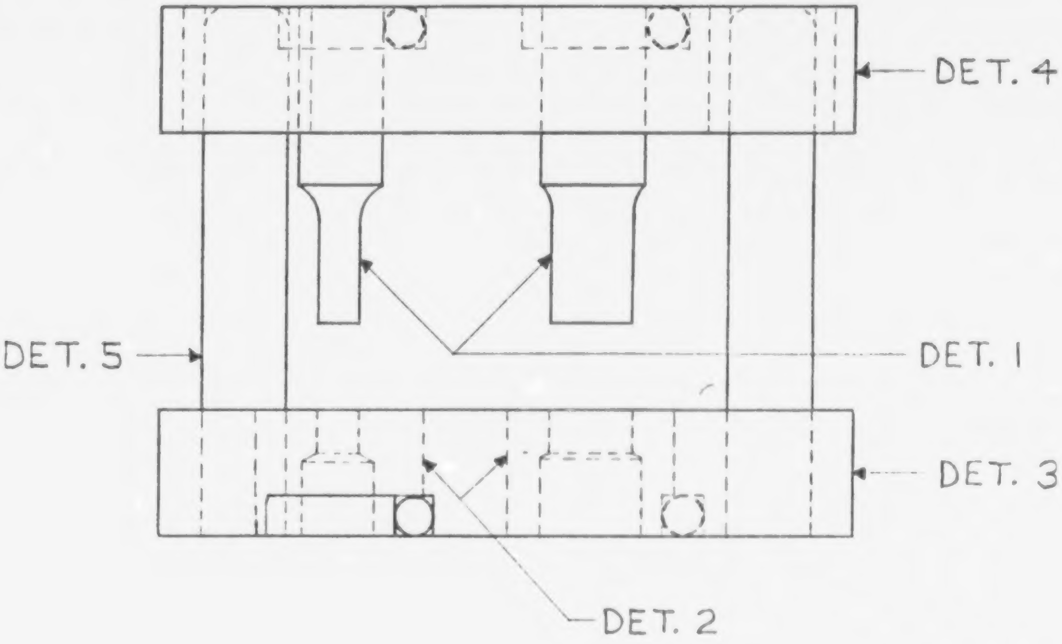
```
N0001/G90
N0002 G92 X     -20000 Y    -20000
N0003 G01 X      13800 Y     10000
N0004 M00

N0005 M80
N0006 M82
N0007 M84
N0008 G90
N0009 G92 X      13800 Y     10000
N0010 G41 X      13800 Y         0F500M90
N0011 G01 X          0 Y      8962
N0012 G01 X          0 Y     16250
N0013 G01 X       3750 Y     12000
N0014 G01 X       1250 Y     20000
N0015 G01 X      16000 Y     20000
N0016 G01 X      19260 Y     23750
N0017 G01 X      23440 Y     23750
N0018 G03 X      28120 Y     19070 I      4680 J          0
N0019 G01 X      28120 Y     10630
N0020 G01 X      25620 Y      8130
N0021 G01 X      25620 Y      4680
N0022 G02 X      20940 Y         0 I     -4680 J          0
N0023 G01 X      13800 Y         0
N0024 M00

N0025 G01 X      13800 Y     10000G40F5000M91
N0026 M02
```

SQUARE OBLONG DIE BILL OF MATERIAL

ITEM	REQ	DESCRIPTION	MATL
1	2	7/8 X2 X1/2	T.S.
2	2	1 D X1 1/4	T.S.
3	2	3/4X 3X 4 1/4	C.R.S.
5	2	9/16DX3 X1/8 or 1/2 Dowel pin	C.R.S.

Notes:

.5 1=7


DET. 4
DET. 5
DET. 1
DET. 3
DET. 2

ANG ± ____
FRAC ± ____
XX ± ____
XXX ± ____
XXXX ± ____

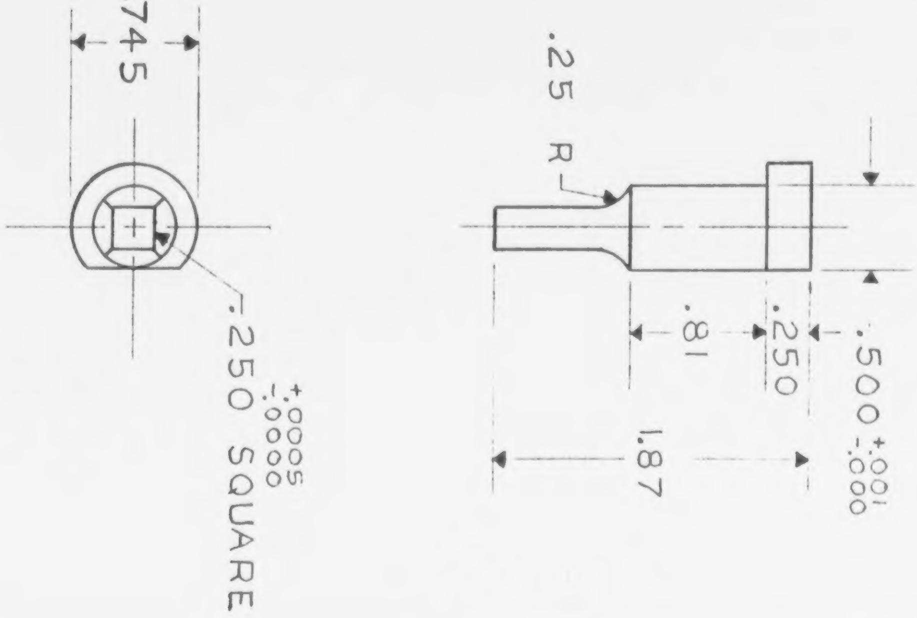
MATL: ____
NO. REQ. 1
DET. NO. ____

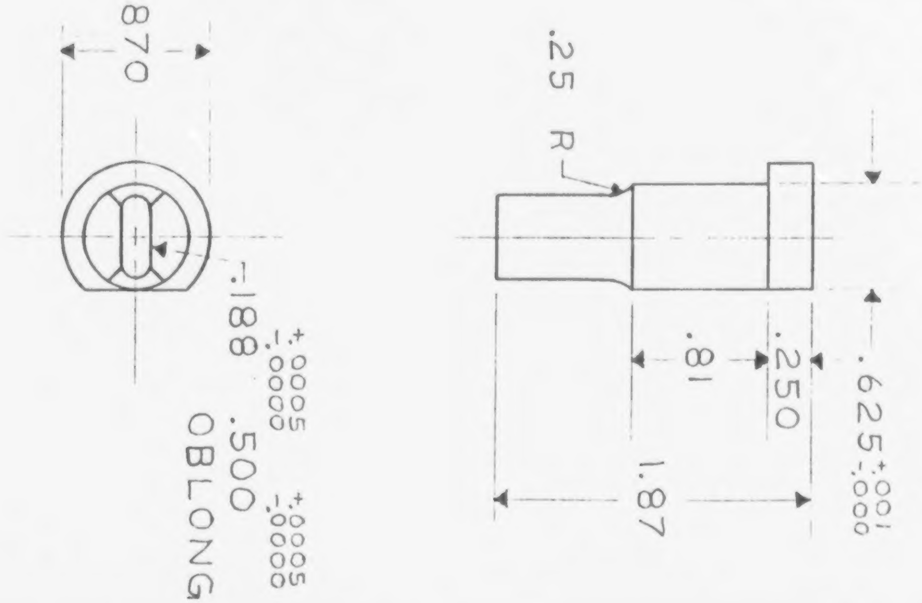
TOOL AND DIE MAKING

SQUARE + OBLONG PIERCE DIE

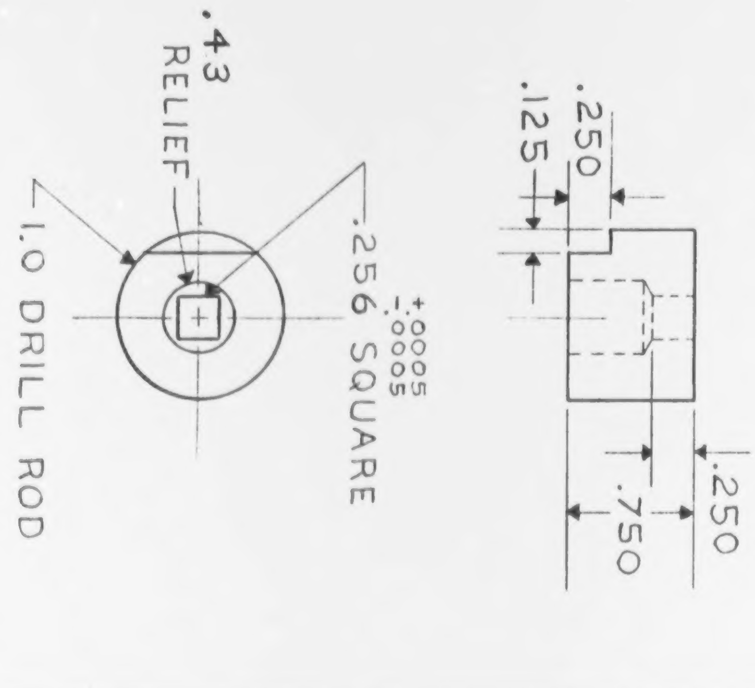
Scale: FULL

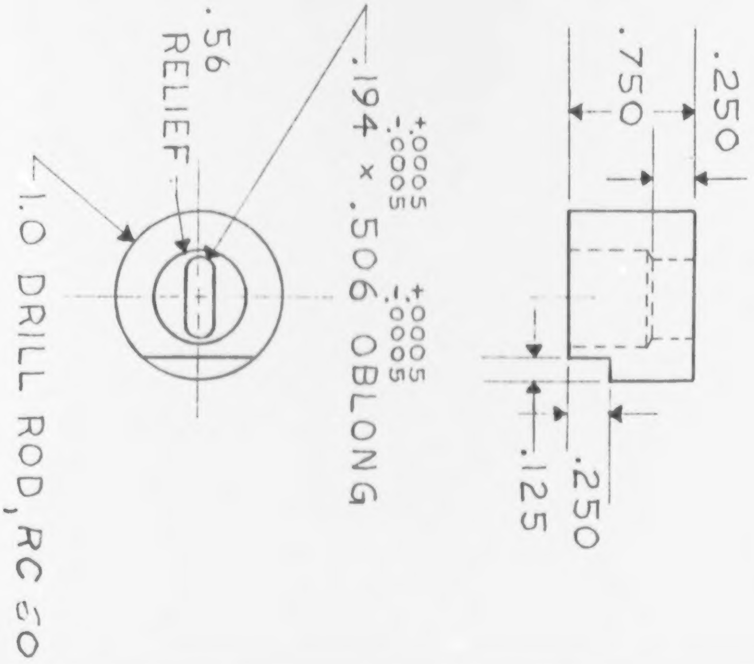
Sh 1 of 6


.745
.25 R
.250 +.0005 -.0000 SQUARE
.500 +.001 -.000
.250
.81
1.87


.870
.25 R
.188 +.0005 -.0000
.500 +.0005 -.0000
OBLONG
.625 +.001 -.000
.250
.81
1.87

ANG ±		MATL: OHTS	TOOL AND DIE MAKING
FRAC ±		NO. REQ. 1 EA.	PUNCHES — — SQ. + OBLONG
XX ±	.01	DET. NO. 1	
XXX ±	.001		Scale: FULL
XXXX ±			Sh 2 of 6


.43
RELIEF
.256 +.0005 -.0005 SQUARE
1.0 DRILL ROD
.250
.125
.750
.250


.56
RELIEF
.194 +.0005 -.0005 × .506 +.0005 -.0005 OBLONG
1.0 DRILL ROD, RC 60
.750
.250
.250
.125

ANG ±
FRAC ±
XX ± .01
XXX ± .001
XXXX ±

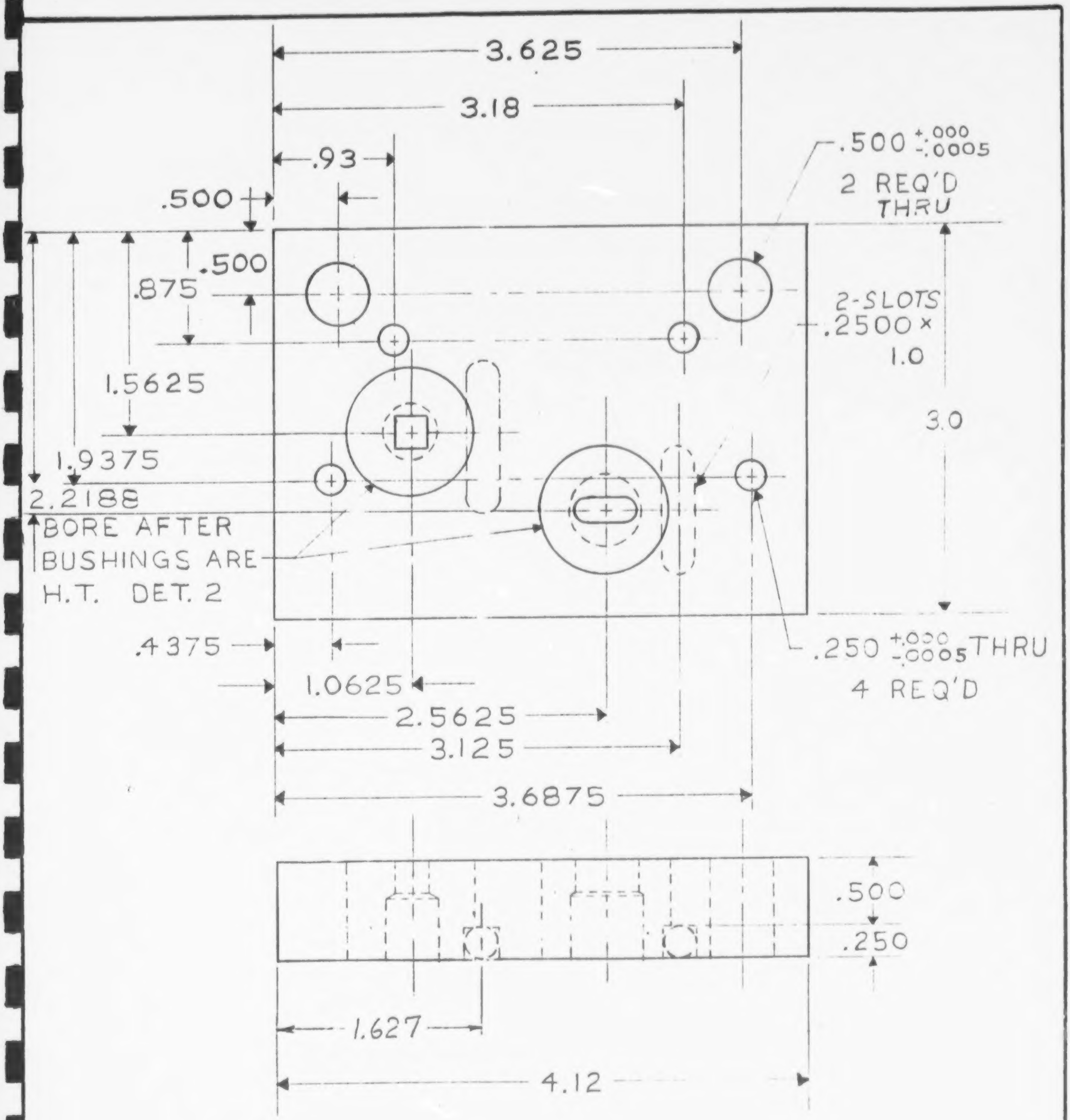
MATL: DRL. ROD
NO. REQ. 1 EA.
DET. NO. 2

TOOL AND DIE MAKING

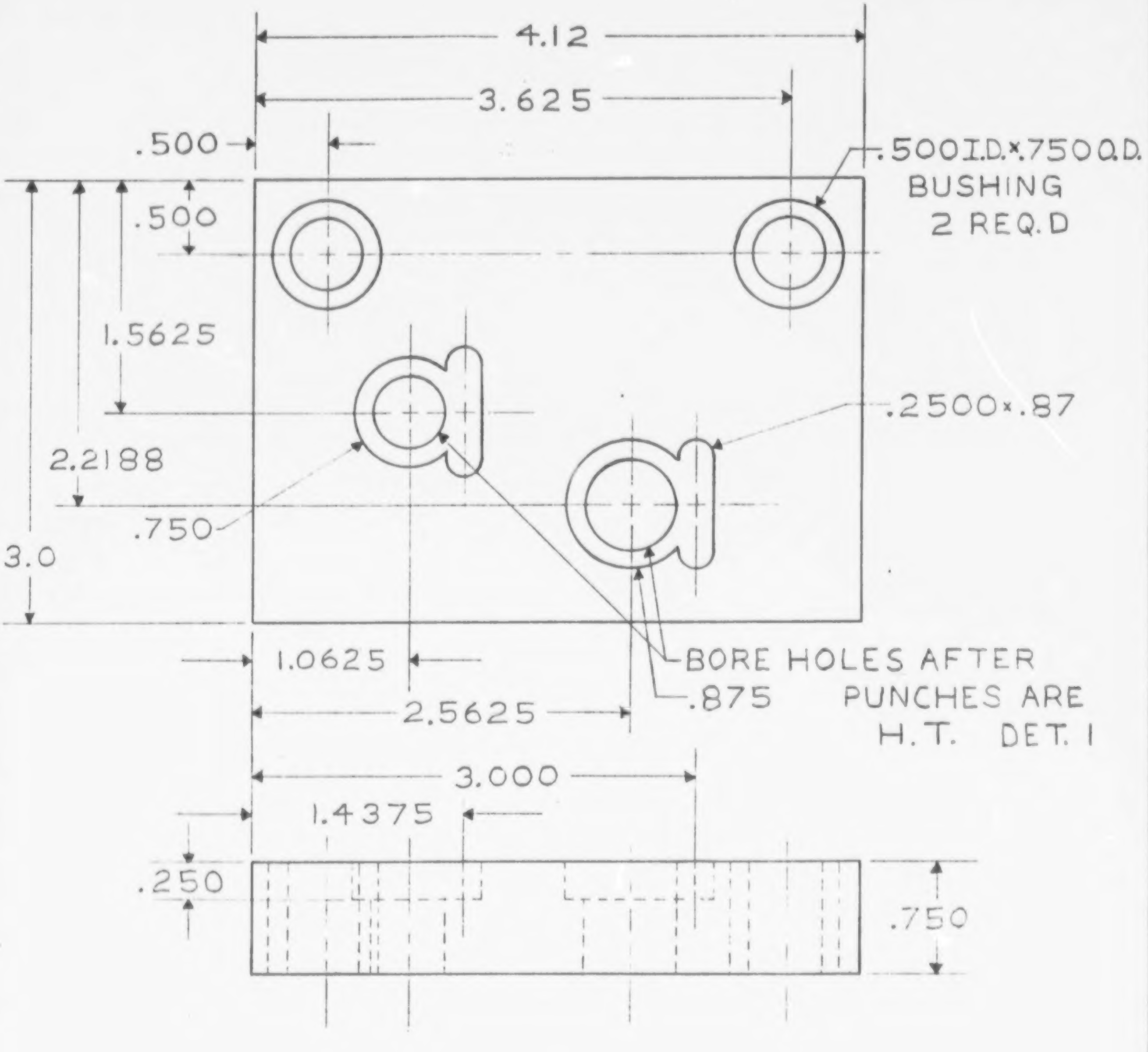
BUTTON DIES

Scale: FULL

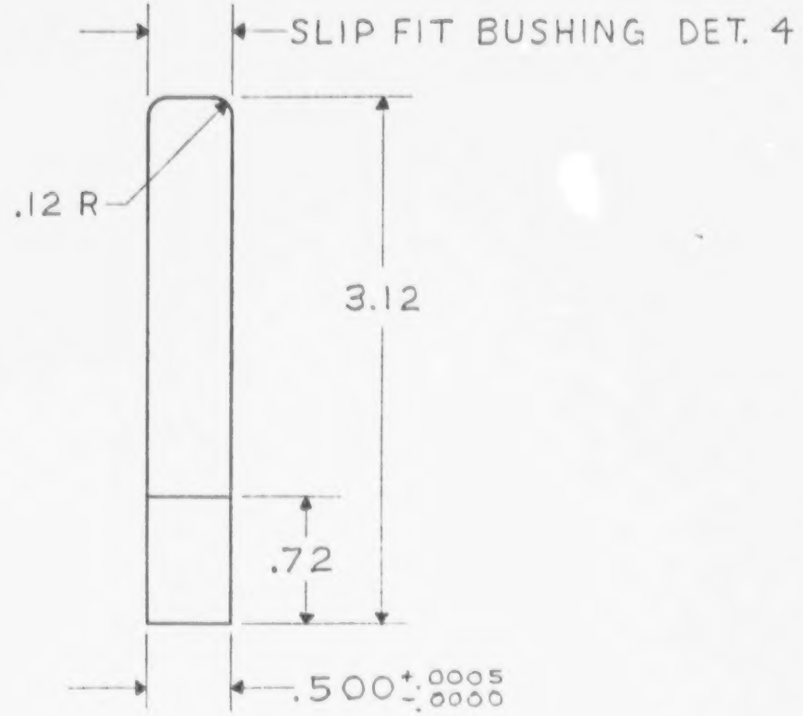
Sh 3 of 6


3.625
3.18
.93
.500
.500 +.000 -.0005
2 REQ'D
THRU
.500
.875
2-SLOTS
.2500 ×
1.0
1.5625
3.0
1.9375
2.2188
BORE AFTER
BUSHINGS ARE
H.T. DET. 2
.4375
.250 +.000 -.0005 THRU
4 REQ'D
1.0625
2.5625
3.125
3.6875
.500
.250
1.627
4.12

ANG ± ___ FRAC ± ___ XX ± .01 XXX ± .001 XXXX ± .0005	MATL: C.R.S. NO. REQ. 1 DET. NO. 3	TOOL AND DIE MAKING DIE SHOE ASSEMBLY	
		Scale: FULL	Sh 4 of 6


4.12
3.625
.500
.500I.D.×.750O.D. BUSHING 2 REQ.D
.500
1.5625
.2500×.87
2.2188
.750
3.0
1.0625
BORE HOLES AFTER PUNCHES ARE H.T. DET. 1
.875
2.5625
3.000
1.4375
.250
.750

ANG ±	MATL: C.R.S.	TOOL AND DIE MAKING
FRAC ±	NO. REQ. 1	PUNCH HOLDER
XX ± .01	DET. NO. 4	Scale: FULL
XXX ± .001		Sh 5 of 6
XXXX ± .0005		


SLIP FIT BUSHING DET. 4
.12 R
3.12
.72
.500 +.0005 -.0000

ANG ±
FRAC ±
XX ± .01
XXX ±
XXXX ±

MATL: CRS
NO. REQ. 2
DET. NO. 5

TOOL AND DIE MAKING

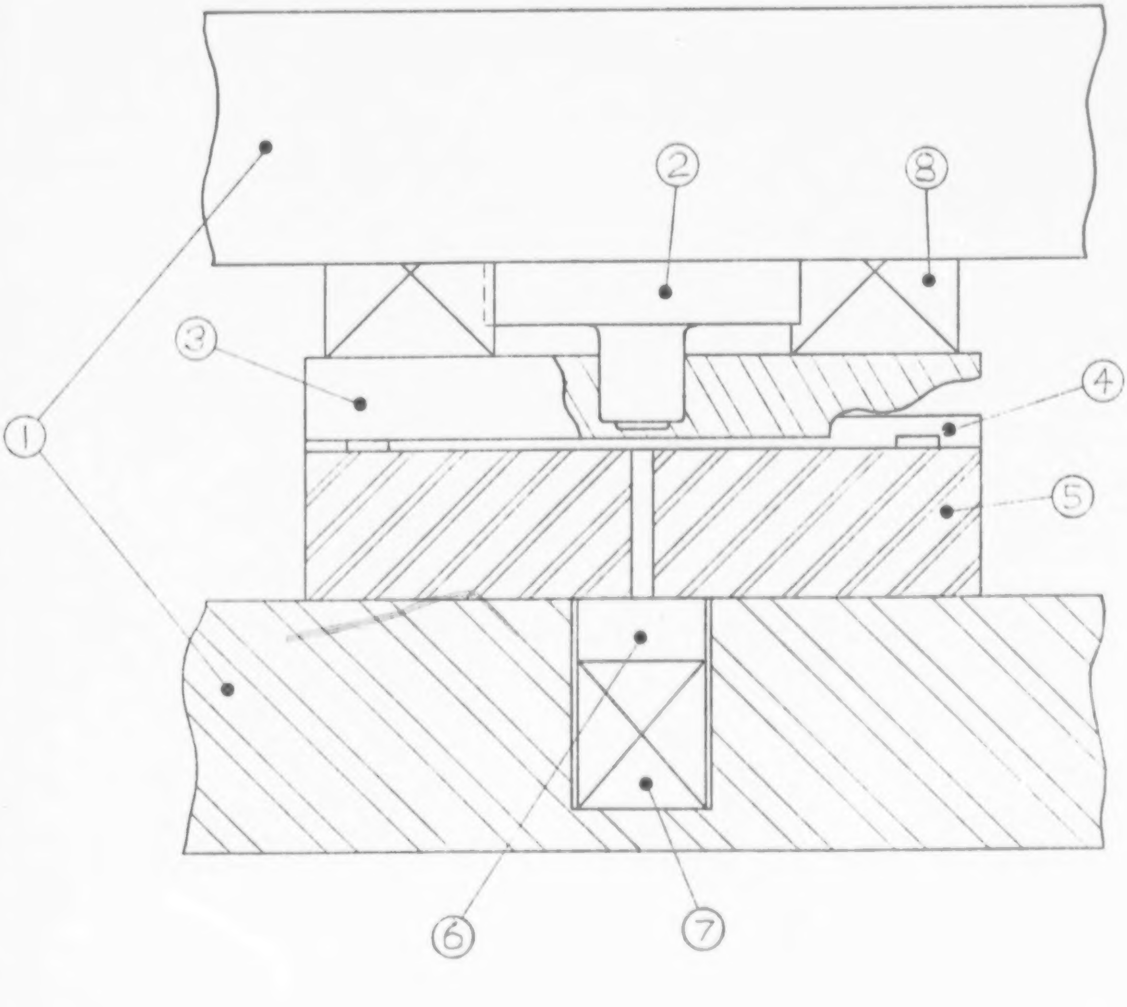
LEADER PIN

Scale: FULL
Sh 6 of 6

SEMI PIERCE DIE

Bill of Materials

DET. NO.	QUANTITY	PART NAME	DESCRIPTION	MATERIAL
1	1	Die Set	Supplied	
2	1	Punch	1 7/8DIA. x 1 1/8	O.H.T.S.
3	1	Stripper	2 1/4 x 4 1/8 x 1/2	C.R.S.
4&5	1 EA.	Spacer & Die Block (with Nest Pins)	Supplied	
6	1	Shedding Pin	7/8DIA. x 1 1/2	C.R.S.
7	1	Spring	3/4DIA. x 1	
8	4	Stripper Springs	1DIA. x 1 1/8	
	4	Stripper Springs	1/4 x 3/4	
	2	Cap Screws	5/16-18 x 1	
	2	Cap Screws	5/16-18 x 1 3/4	
	2	Dower Pin	1/4 x 1 1/2	
	4	Stripper Bolts	3/8-16 x 1 1/2	



ANG ± ______
FRAC ± ______
XX ± ______
XXX ± ______
XXXX ± ______

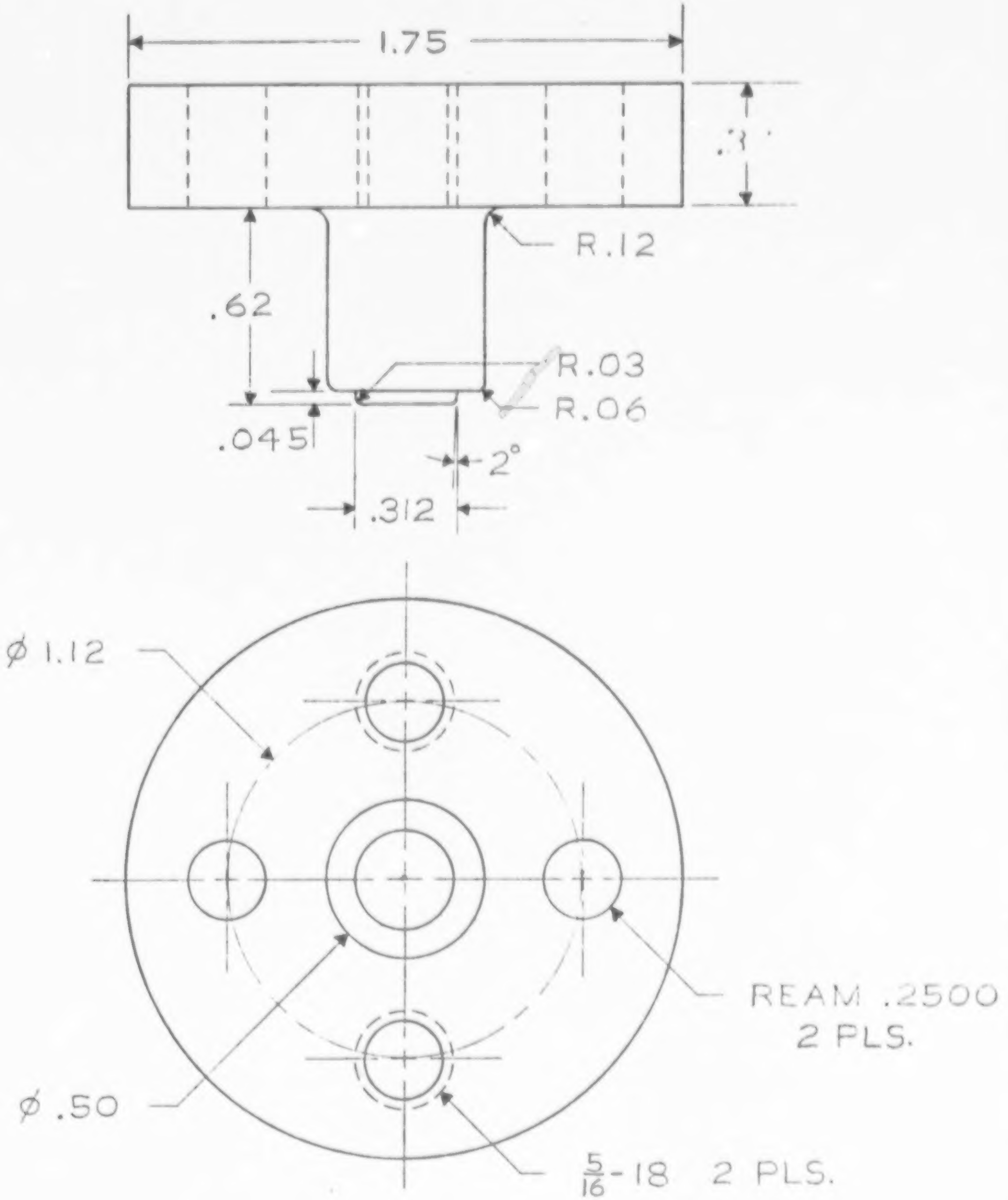
MATL: ______
NO. REQ. ______
DET. NO. ______

TOOL AND DIE MAKING

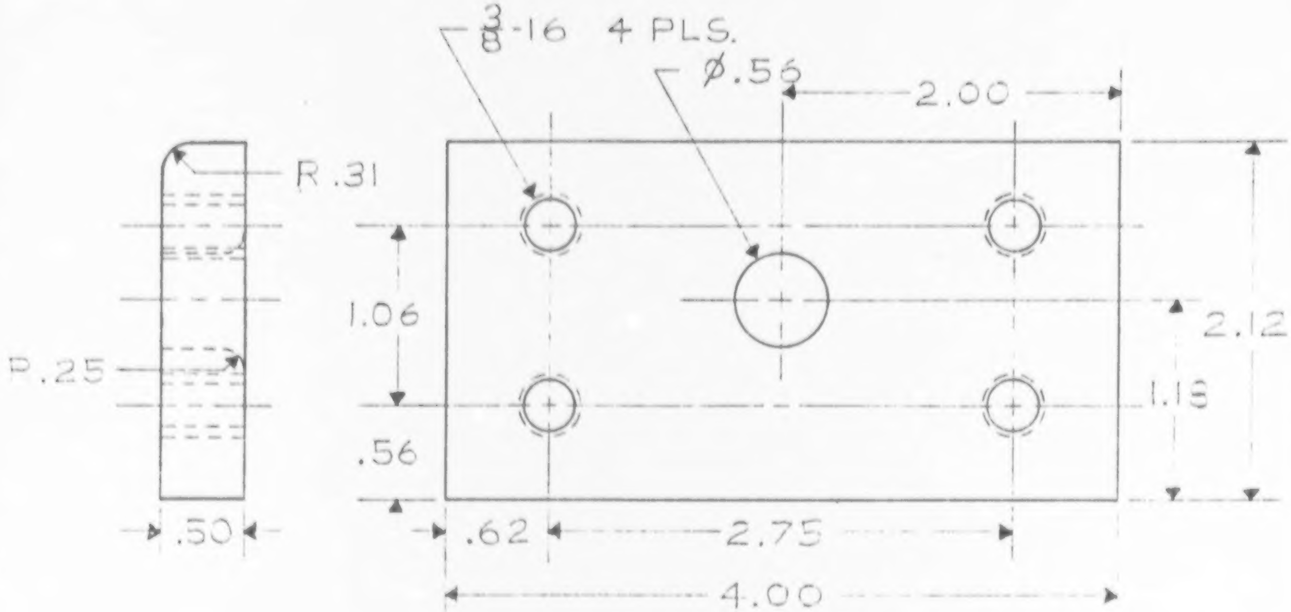
SEMIPIERCE DIE

Scale: FULL

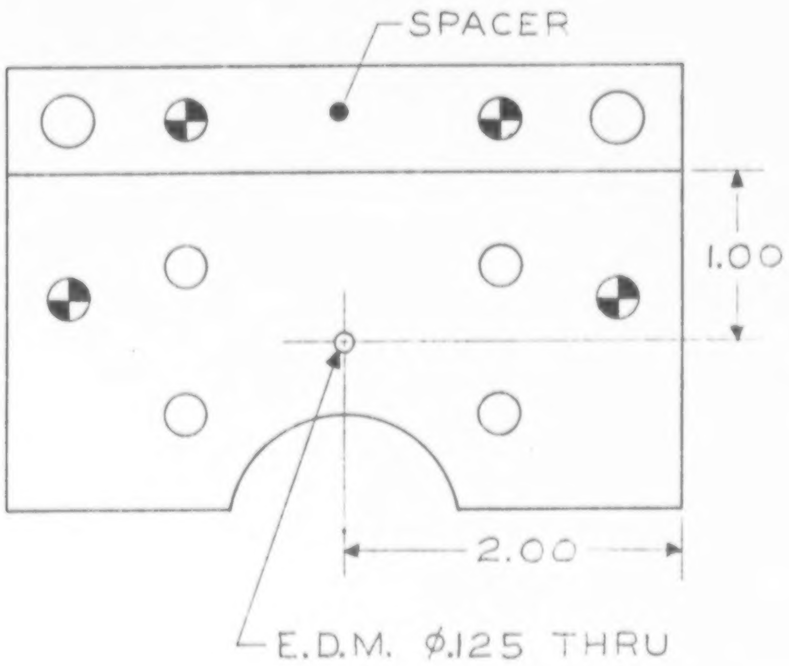
Sh 2 of 6


1.75
.3
R.12
.62
R.03
R.06
.045
2°
.312
Ø 1.12
REAM .2500
2 PLS.
Ø .50
5/16-18 2 PLS.

ANG ± ___ FRAC ± ___ XX ± .01 XXX ± .002 XXXX ± .0005	MATL: O.H.T.S. NO. REQ. 1 DET. NO. 2	TOOL AND DIE MAKING PUNCH Scale: 2:1 — Sh 3 of 6


3/8-16 4 PLS.
Ø.56
2.00
R .31
1.06
2.12
R .25
1.18
.56
.50
.62
2.75
4.00

ANG ± FRAC ± XX ± .01 XXX ± XXXX ±	MATL: C.R.S. NO. REQ. 1 DET. NO. 3	TOOL AND DIE MAKING STRIPPER Scale: FULL Sh 4 of 6


SPACER
1.00
2.00
E.D.M. ϕ.125 THRU

ANG ±
FRAC ±
XX ± .01
XXX ± .002
XXXX ±

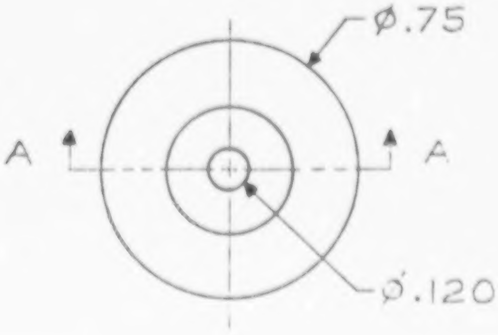
MATL: O.H.T.S.
NO. REQ. 1
DET. NO. 4+5

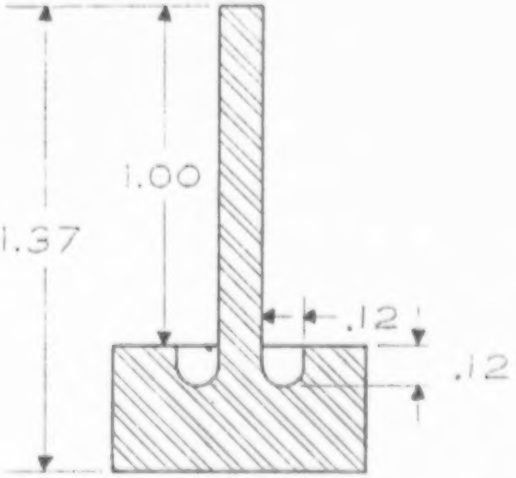
TOOL AND DIE MAKING

DIE BLOCK

Scale: FULL

Sh 5 of 6



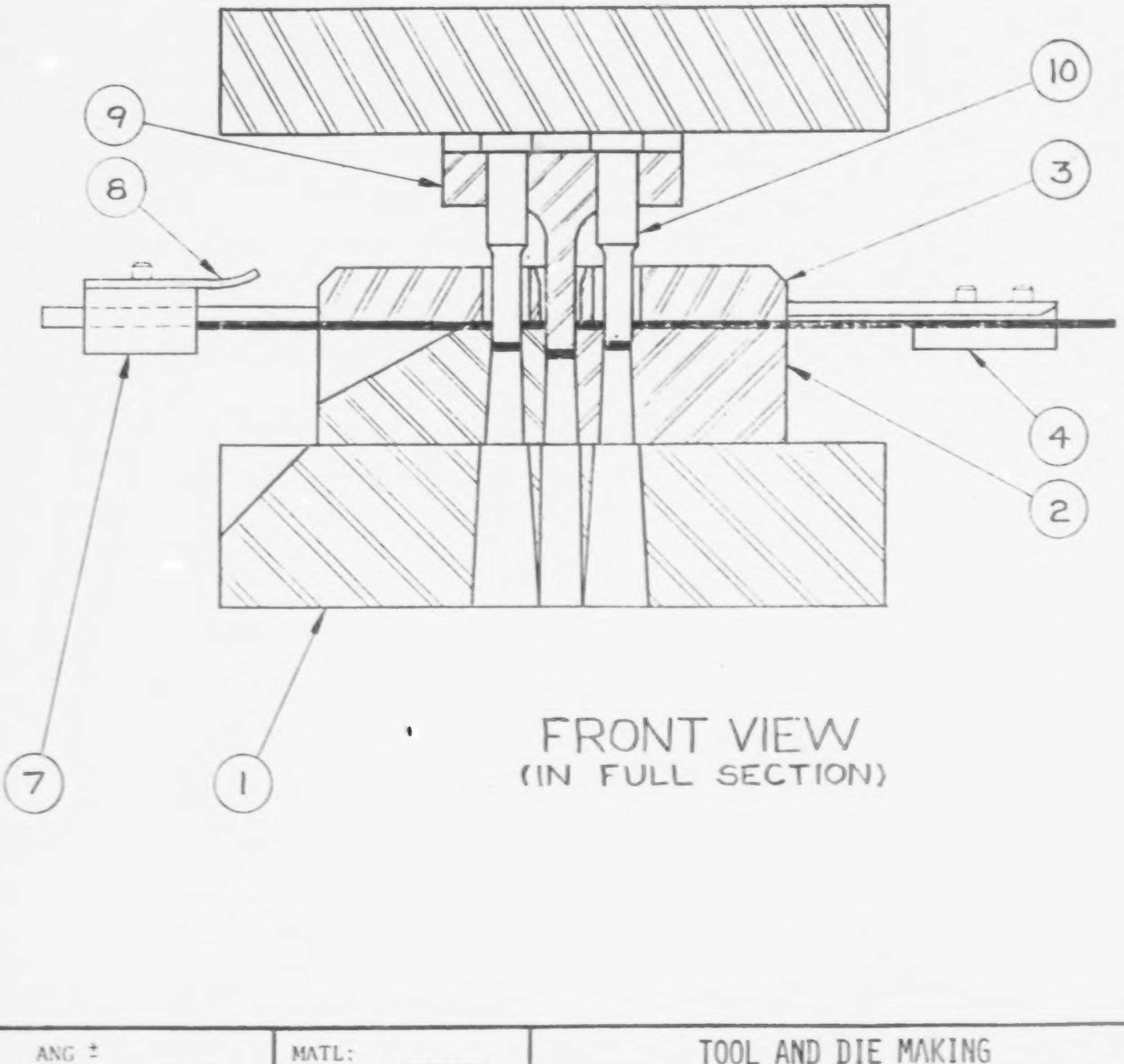

1.00
1.37
.12
.12

SECTION A-A

ANG ±		MATL: C.R.S.	TOOL AND DIE MAKING	
FRAC ±		NO. REQ. 1	SHEDDING PIN	
XX ±	.01	DET. NO. 6		
XXX ±	.002		Scale: 2:1	Sh 6 of 6
XXXX ±				

PIERCE & PART

FILE NAME	PRINT NAME
A: PUP&P	PUNCH



FRONT VIEW
(IN FULL SECTION)

ANG ± ______
FRAC ± ______
XX ± ______
XXX ± ______
XXXX ± ______

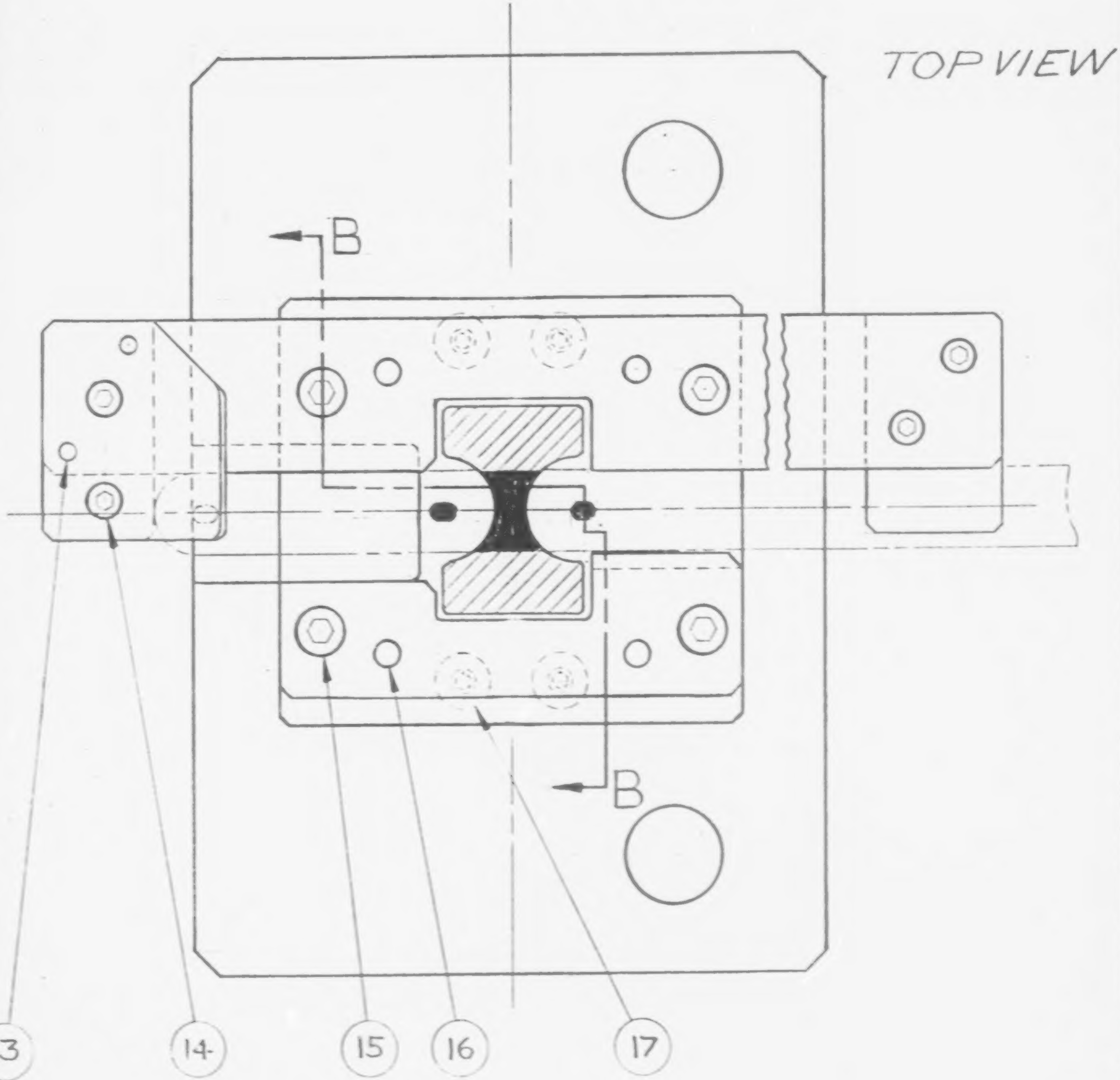
MATL: ______
NO. REQ. ______
DET. NO. ______

TOOL AND DIE MAKING

PIERCE & PART DIE

Scale: NONE

Sh 1 of 12


TOP VIEW
B
B
13
14
15
16
17

ANG ± ______
FRAC ± ______
XX ± ______
XXX ± ______
XXXX ± ______

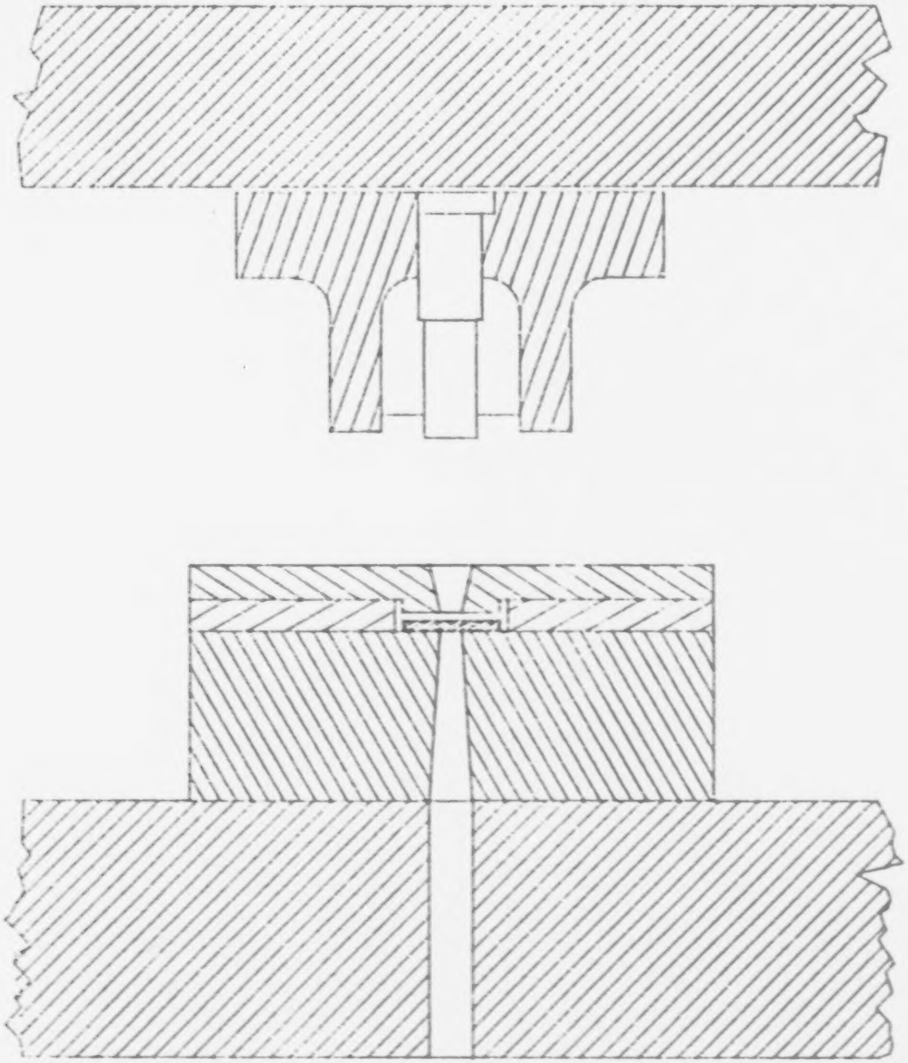
MATL: ______
NO. REQ. ______
DET. NO. ______

TOOL AND DIE MAKING

PIERCE & PART DIE

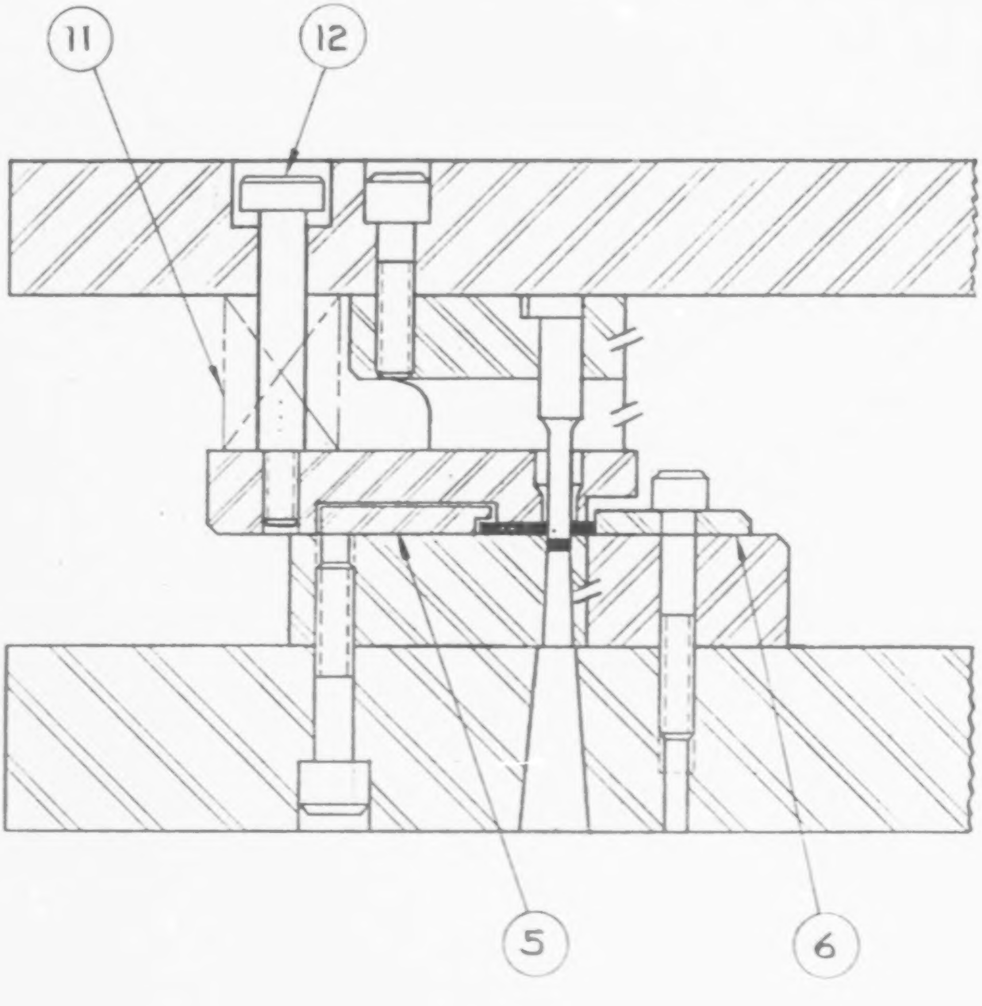
Scale: NONE

Sh 2 of 12



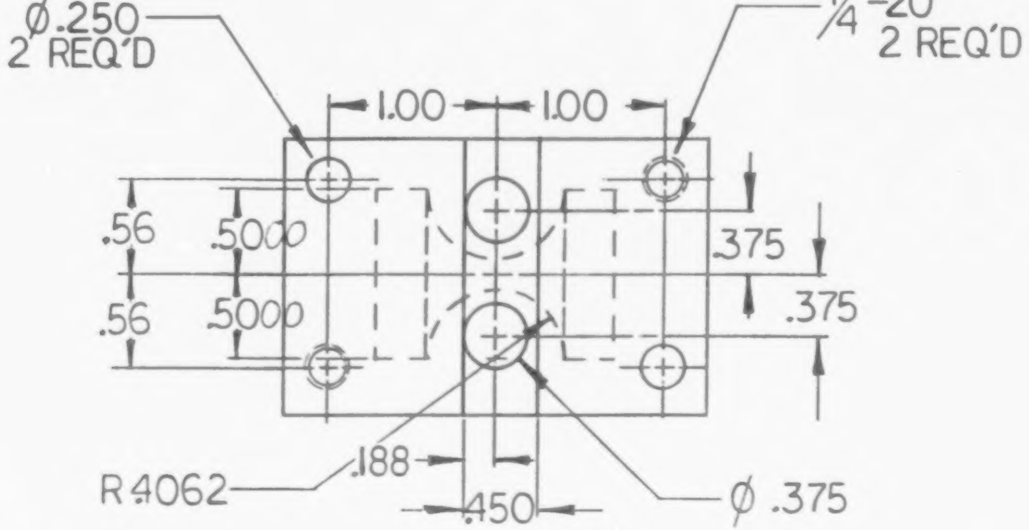
RIGHT-SIDE VIEW

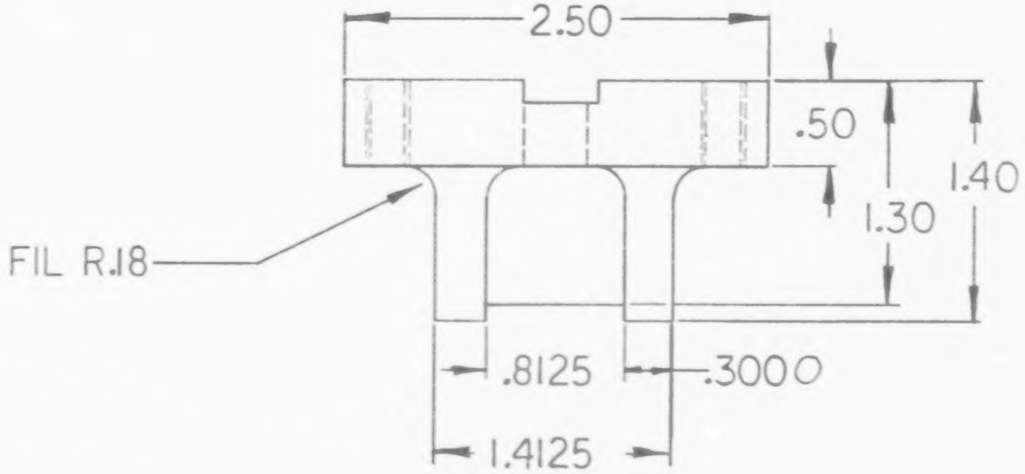
TOLERANCES UNLESS SPECIFIED					NO. REQUIRED	MATERIAL	DESCRIPTION PIERCE & PART DIE
DECIMALS							
1 PLACE	2 PLACE	3 PLACE	4 PLACE	ANGLES	DETAIL NO.	DRAWN BY	
N/A	N/A	N/A	N/A	N/A	SHEET 3 of 12	DATE	PART No.



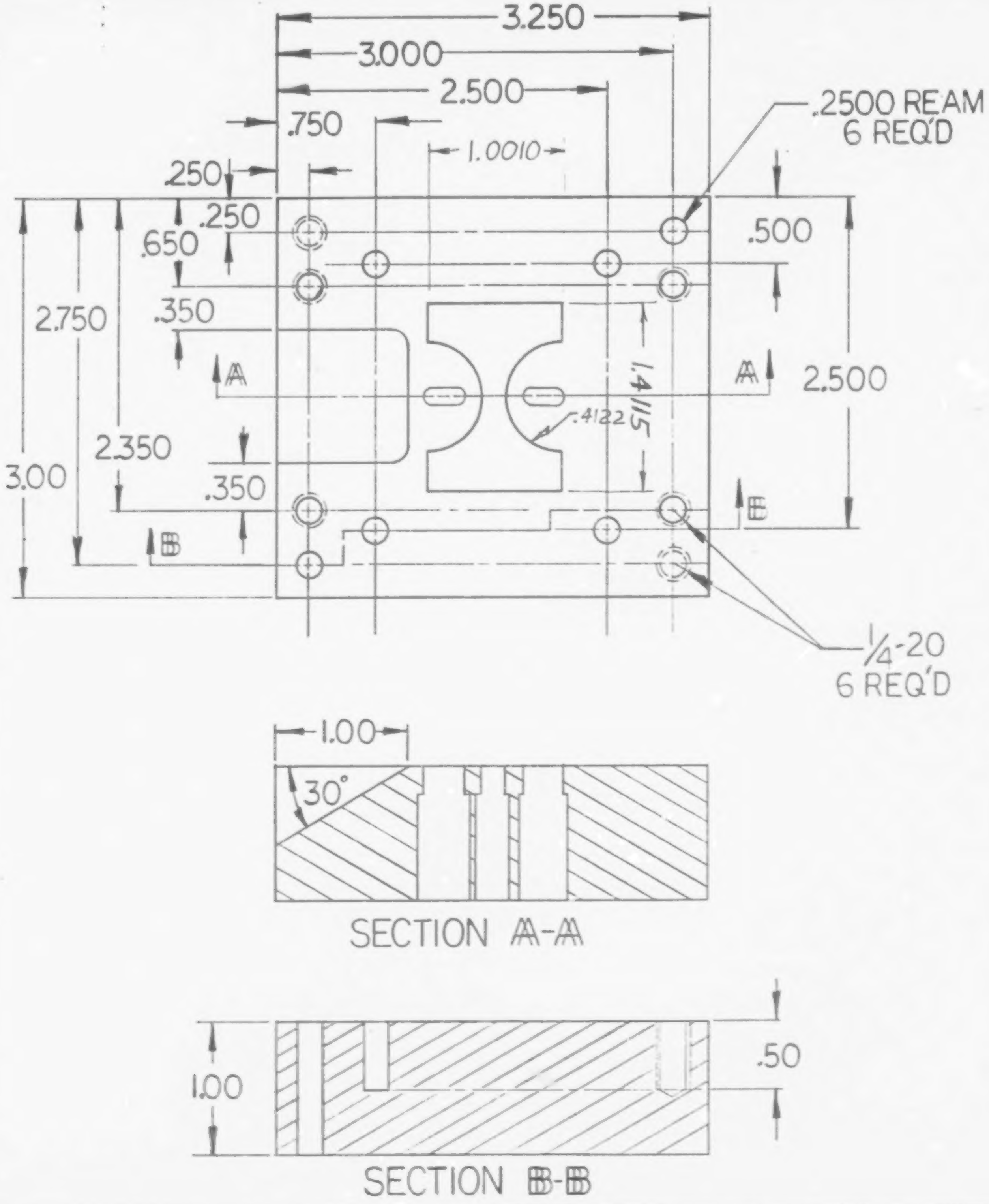
SECTION B-B

ANG ± FRAC ± XX ± XXX ± XXXX ±	MATL: NO. REQ. DET. NO.	TOOL AND DIE MAKING PIERCE & PART DIE Scale: NONE Sh 4 of 12


Ø.250
2 REQ'D
¼-20
2 REQ'D
1.00
1.00
.56
.56
.5000
.5000
.375
.375
R.4062
.188
.450
Ø .375


2.50
.50
1.40
1.30
FIL R.18
.8125
.3000
1.4125

ANG ± FRAC ± 1/32 XX ± .01 XXX ± .003 XXXX ± .0005	MATL: NO. REQ. 1 DET. NO. PSUIK 88	TOOL AND DIE MAKING PUNCH Scale: FULL Sh 5 of 12


3.250
3.000
2.500
.750
1.0010
.250
.250
.650
.2500 REAM
6 REQ'D
.500
2.750
.350
A
A
2.500
1.4115
.4122
2.350
.350
3.00
B
B
¼-20
6 REQ'D
1.00
30°
SECTION A-A
1.00
.50
SECTION B-B

ANG ±	3°	
FRAC ±	1/64	
XX ±	.01	
XXX ±	.003	
XXXX ±	.0005	

MATL: ______
NO. REQ. ______
DET. NO. ______

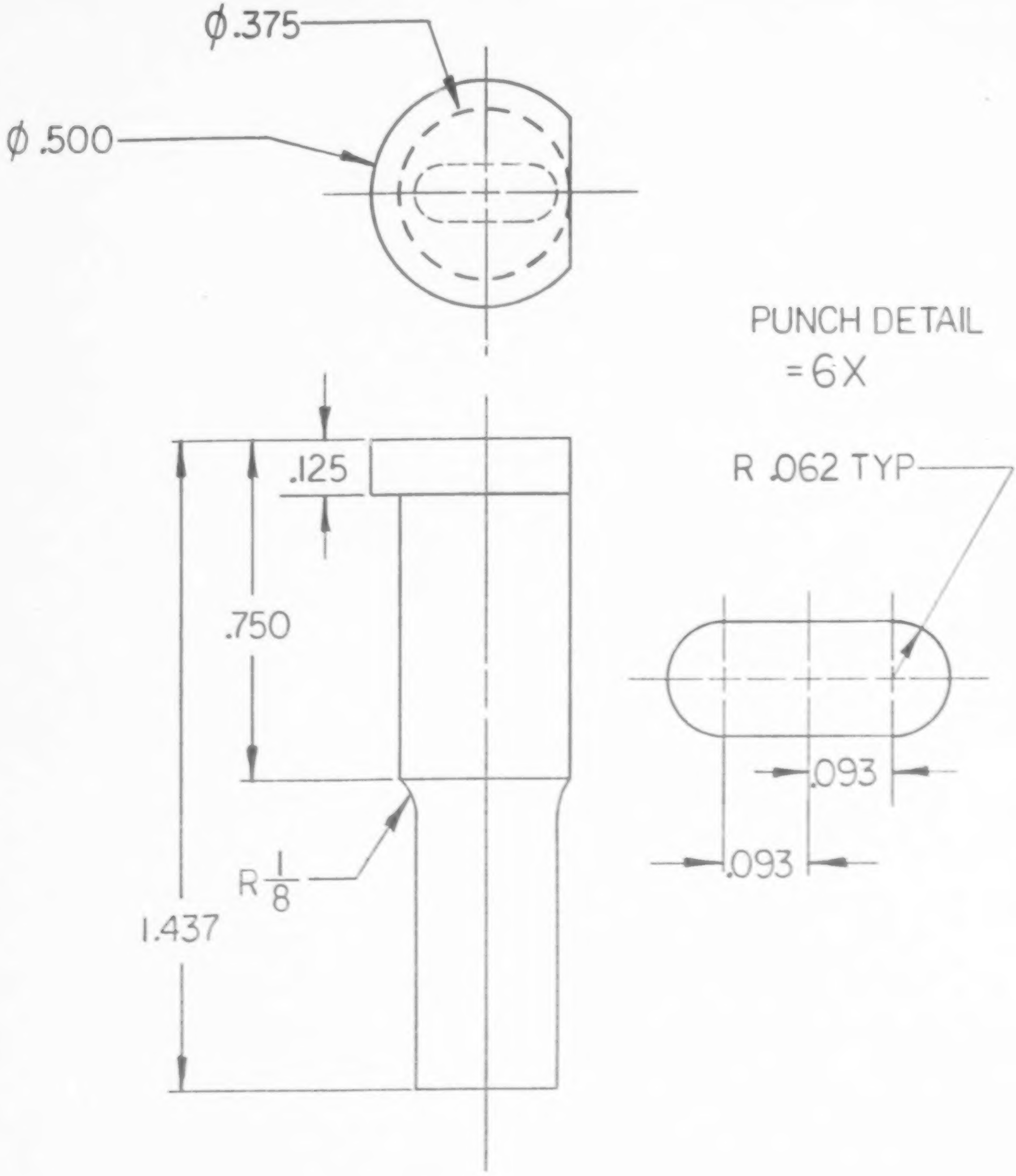
PSUIK

TOOL AND DIE MAKING

DIE BLOCK

Scale: FULL

Sh 6 of 12



ϕ.375
ϕ.500
PUNCH DETAIL
=6X
.125
R .062 TYP
.750
.093
R 1/8
.093
1.437

ANG ±
FRAC ± 1/32
XX ± .01
XXX ± .003
XXXX ± .0005

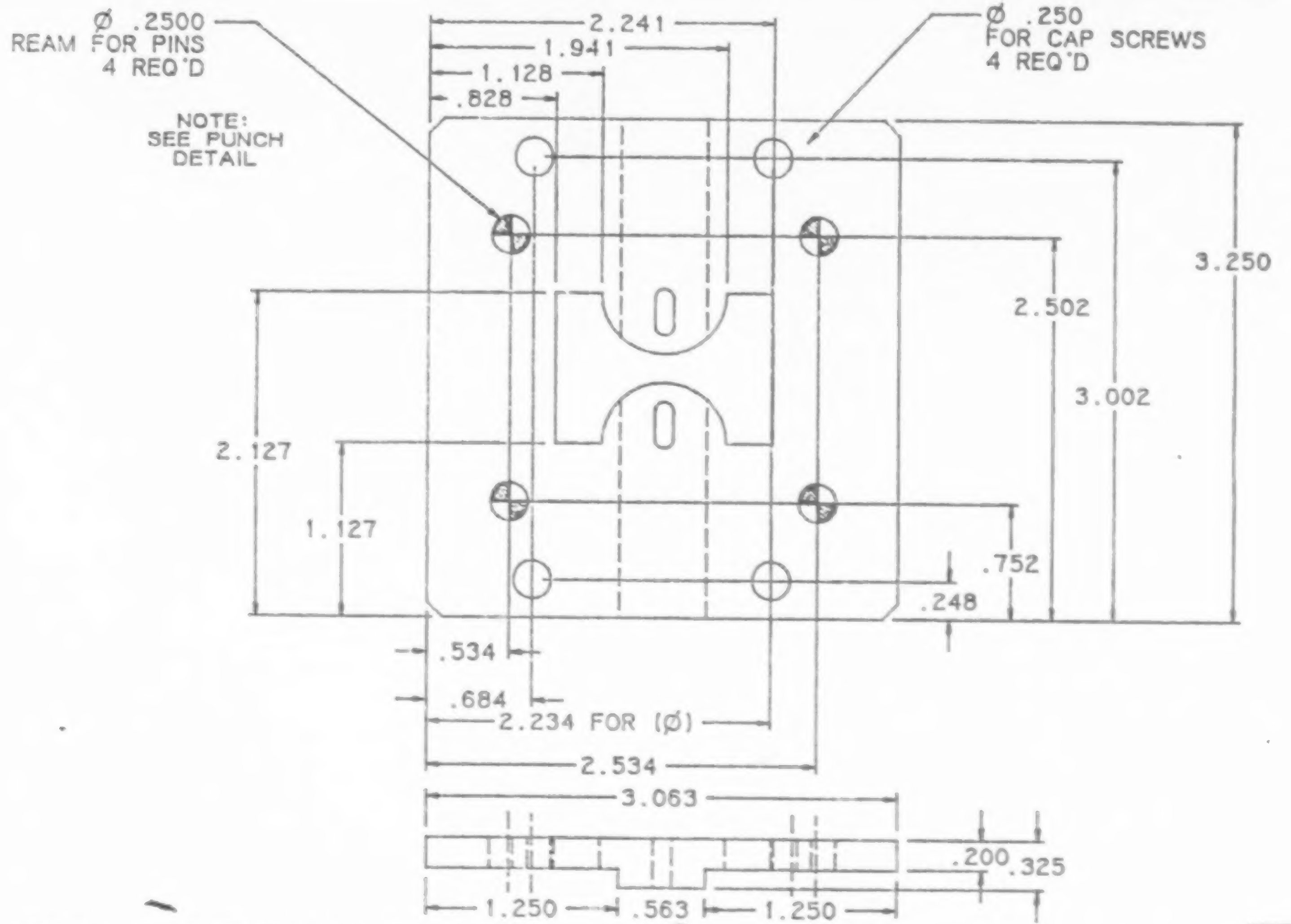
MATL:
NO. REQ. 2
DET. NO.

TOOL AND DIE MAKING

HOLE PUNCH

Scale: 3X

Sh 7 of 12


Ø .2500
REAM FOR PINS
4 REQ'D
NOTE:
SEE PUNCH
DETAIL
2.241
1.941
1.128
.828
Ø .250
FOR CAP SCREWS
4 REQ'D
3.250
2.502
3.002
2.127
1.127
.752
.248
.534
.684
2.234 FOR (Ø)
2.534
3.063
.200
.325
1.250
.563
1.250
STOCK WIDTH

TOOL & DIE MAKING

A. DIEGUIO

TOLERANCES UNLESS SPECIFIED				
DECIMALS				
1 PLACE	2 PLACE	3 PLACE	4 PLACE	ANGLES
±.1	±.01	±.005	±.0005	±2

NO. REQUIRED 1

DETAIL NO.

SHEET 8 OF 12

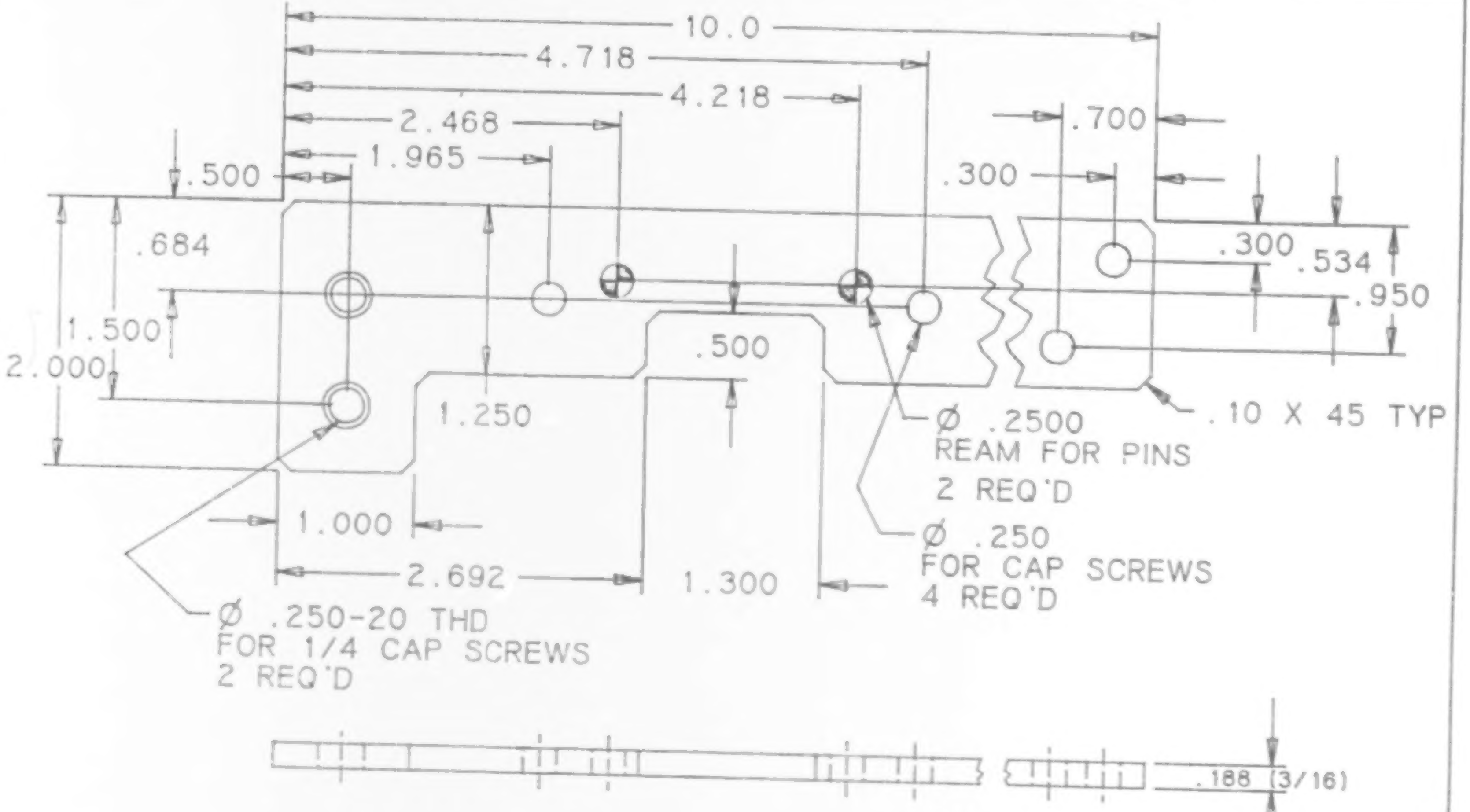
MATERIAL

DRAWN BY

DATE

DESCRIPTION DIE GUIDE

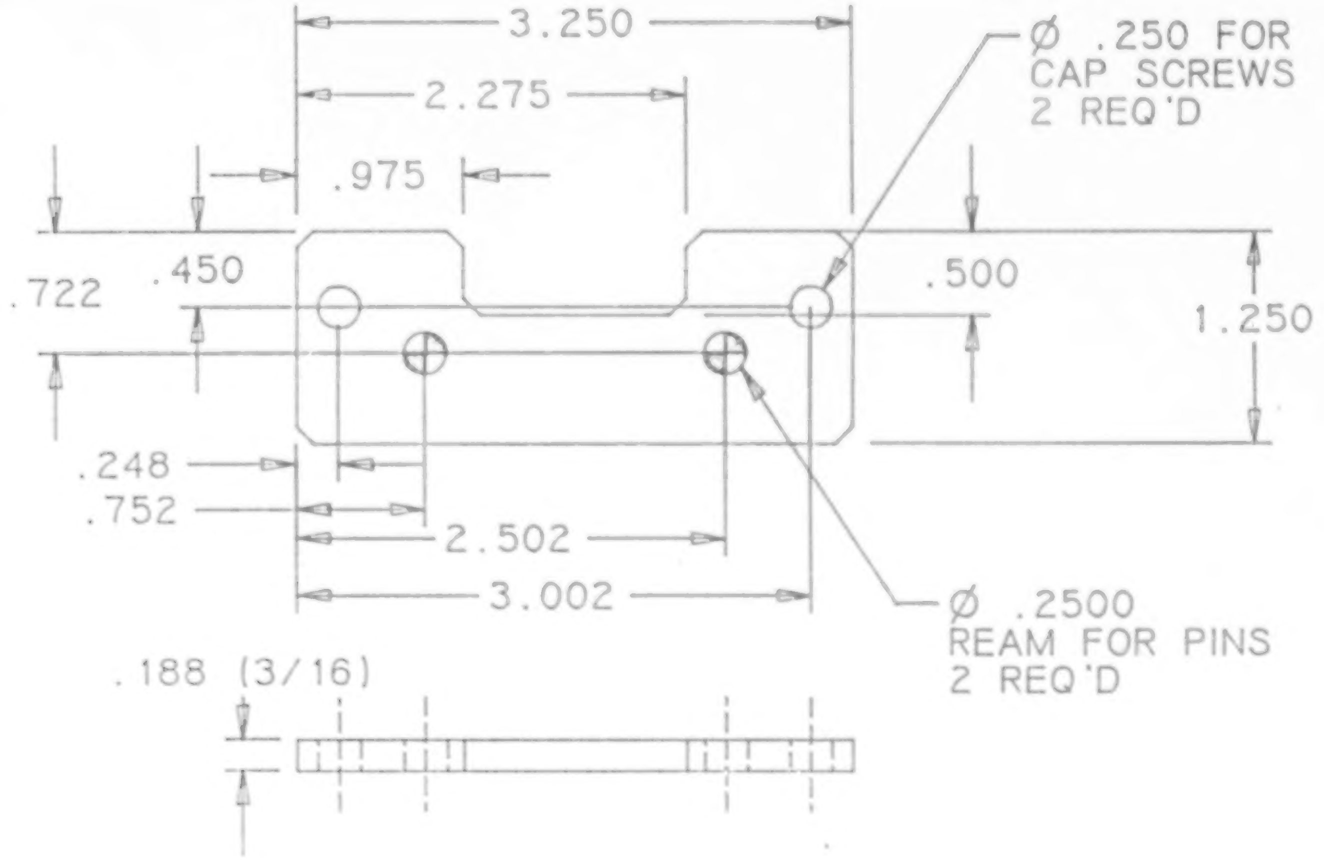
PART No. 000-111


10.0
4.718
4.218
2.468
1.965
.500
.700
.300
.684
1.500
2.000
1.250
.500
.300
.534
.950
.10 X 45 TYP
Ø .2500
REAM FOR PINS
2 REQ'D
Ø .250
FOR CAP SCREWS
4 REQ'D
1.000
2.692
1.300
Ø .250-20 THD
FOR 1/4 CAP SCREWS
2 REQ'D
.188 (3/16)

TOOL & DIE MAKING

matc

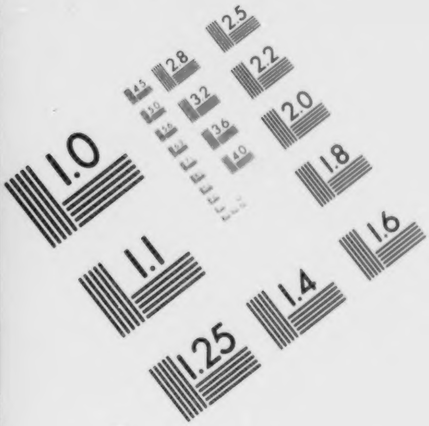
TOLERANCES UNLESS SPECIFIED					NO. REQUIRED	MATERIAL	DESCRIPTION
DECIMALS					1		LONG GUIDE PLATE
1 PLACE	2 PLACE	3 PLACE	4 PLACE	ANGLES	DETAIL NO.	DRAWN BY J. PSUIK	
±.1	±.01	±.005	±.0005	±2	SHEET 9 OF 12	DATE FALL 1988	PART No. 000-111


3.250
2.275
.975
Ø .250 FOR CAP SCREWS 2 REQ'D
.722
.450
.500
1.250
.248
.752
2.502
3.002
Ø .2500 REAM FOR PINS 2 REQ'D
.188 (3/16)

TOOL AND DIE MAKING

matc

TOLERANCES UNLESS SPECIFIED					NO. REQUIRED 1	MATERIAL	DESCRIPTION SHORT GUIDE PLATE
DECIMALS							
1 PLACE	2 PLACE	3 PLACE	4 PLACE	ANGLES	DETAIL NO.	DRAWN BY	
±.1	±.01	±.005	±.0005	±2	SHEET 10 OF 12	DATE	PART No. 000-111

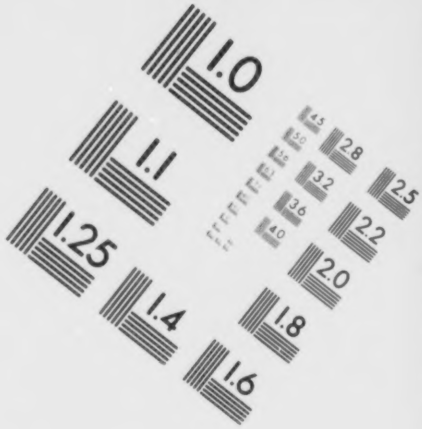

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

AIIM

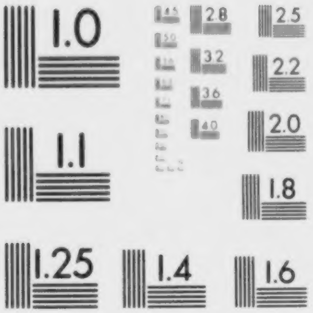
Association for Information and Image Management

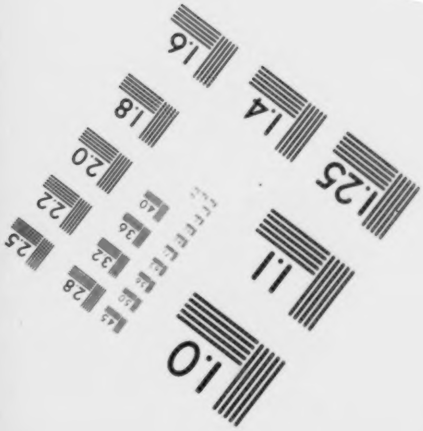
1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

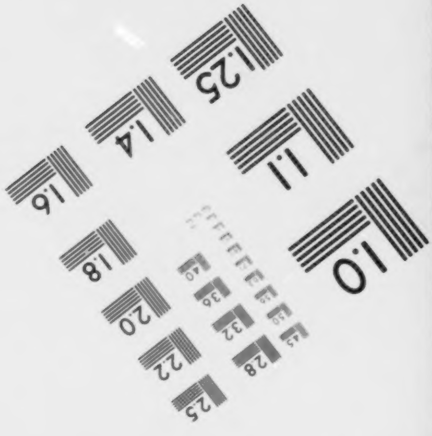
301/587-8202


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

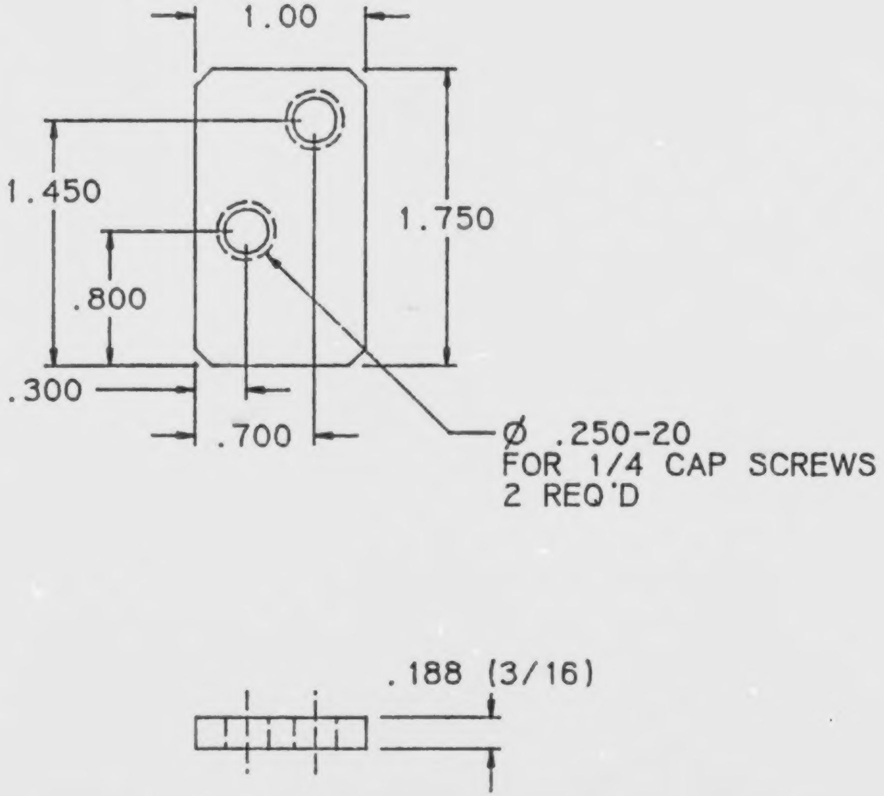
Centimeter
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
mm
1
2
3
4
5
Inches


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

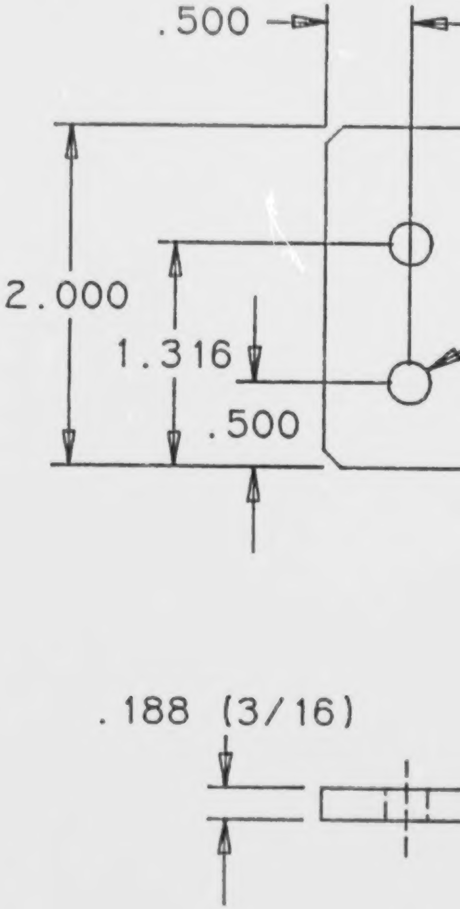
MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.


1.00
1.450
1.750
.800
.300
.700
Ø .250-20
FOR 1/4 CAP SCREWS
2 REQ'D
.188 (3/16)

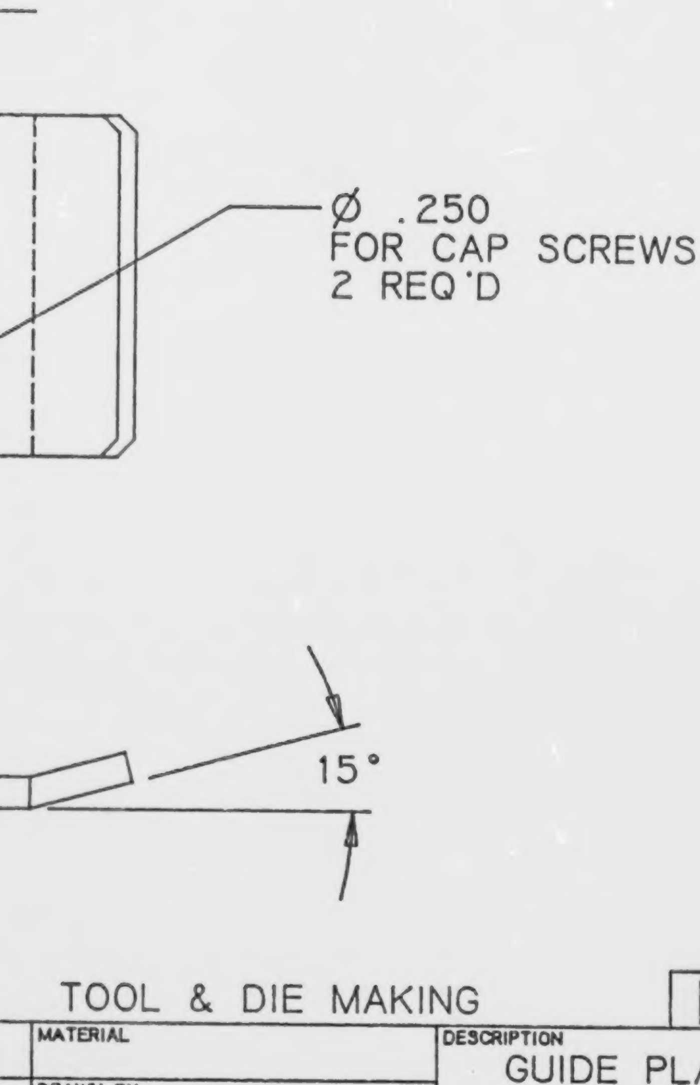
TOOL & DIE MAKING

matc

TOLERANCES UNLESS SPECIFIED					NO. REQUIRED 1	MATERIAL	DESCRIPTION PIECE HOLDER
DECIMALS					DETAIL NO.	DRAWN BY	
1 PLACE	2 PLACE	3 PLACE	4 PLACE	ANGLES			
±.1	±.01	±.005	±.0005	±2	SHEET 11 OF 12	DATE	PART No. 000-111


.500
2.000
1.316
.500
.188 (3/16)

TOLERANCES UNLESS SPECIFIED					NO. REQUIRED 1
DECIMALS					
1 PLACE	2 PLACE	3 PLACE	4 PLACE	ANGLES	DETAIL NO.
±.1	±.01	±.005	±.0005	±2	SHEET 12 OF 12


Ø .250
FOR CAP SCREWS
2 REQ'D
15°

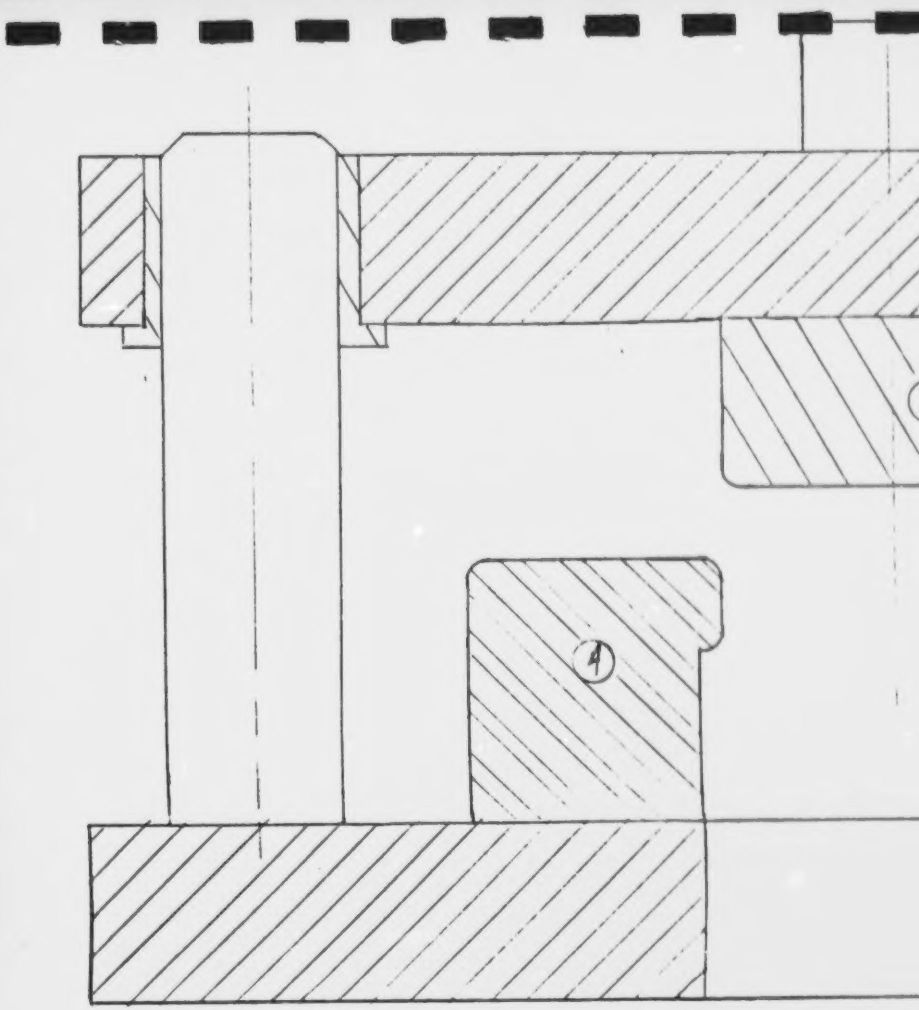
TOOL & DIE MAKING

MATERIAL	DESCRIPTION GUIDE PLATE END
DRAWN BY	
DATE	PART No. 000-111

CUT-OFF DIE

BILL OF MATERIAL

No.	NAME	QUAN.	MAT.	SIZE	REMARKS
4	Die Block	1	TS	Bin. No. 57	1 x 1 13/16 x 3 5/16
5	Punch	1	TS	Bin. No. 57	1 x 2 1/8 x 2 1/8
6	Stripper	1	TS	Bin No. 57	1/2 x 3 1/2 x 1 5/8
7	Wiper	1	TS	Bin No. 57	1 1/2 x 3 1/2 x 1 1/2
	Pins	6	STD		1/4 Dia.
	Allen Screws	8	STD		1/4
	Die Set	1	STD		



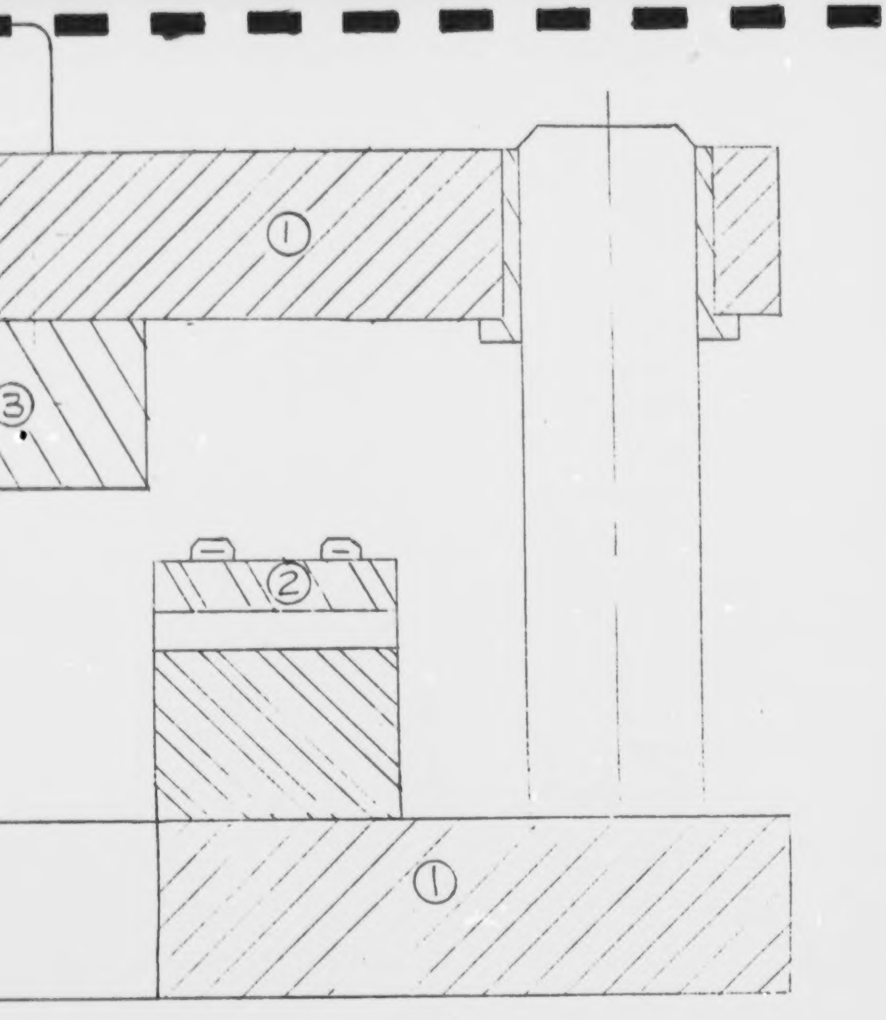
① DIE SET

② STRIPPER

③ PUNCH

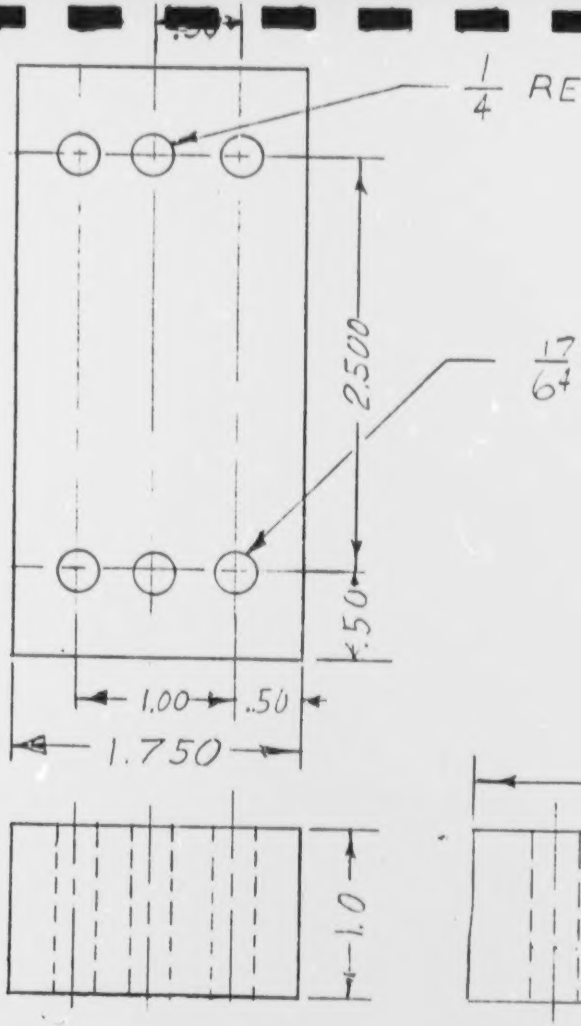
COURSE
TOOL& DIE

SCA



④ WIPER

LE	MAT. T.S	CUT OFF DIE	4-7

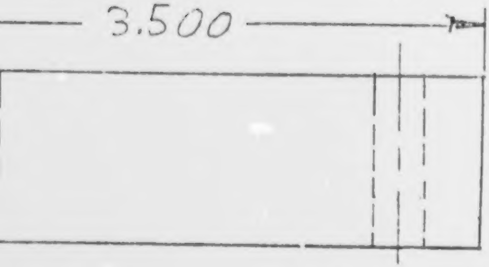

.50
1/4 RE
17/64
2.500
.50
1.00
.50
1.750
1.0

TOLERANCE
.X ± .05
.XX ± .005
.XXX ± .0005

COURSE	SCALE
TOOL & DIE	FULL

AM 2 HOLES

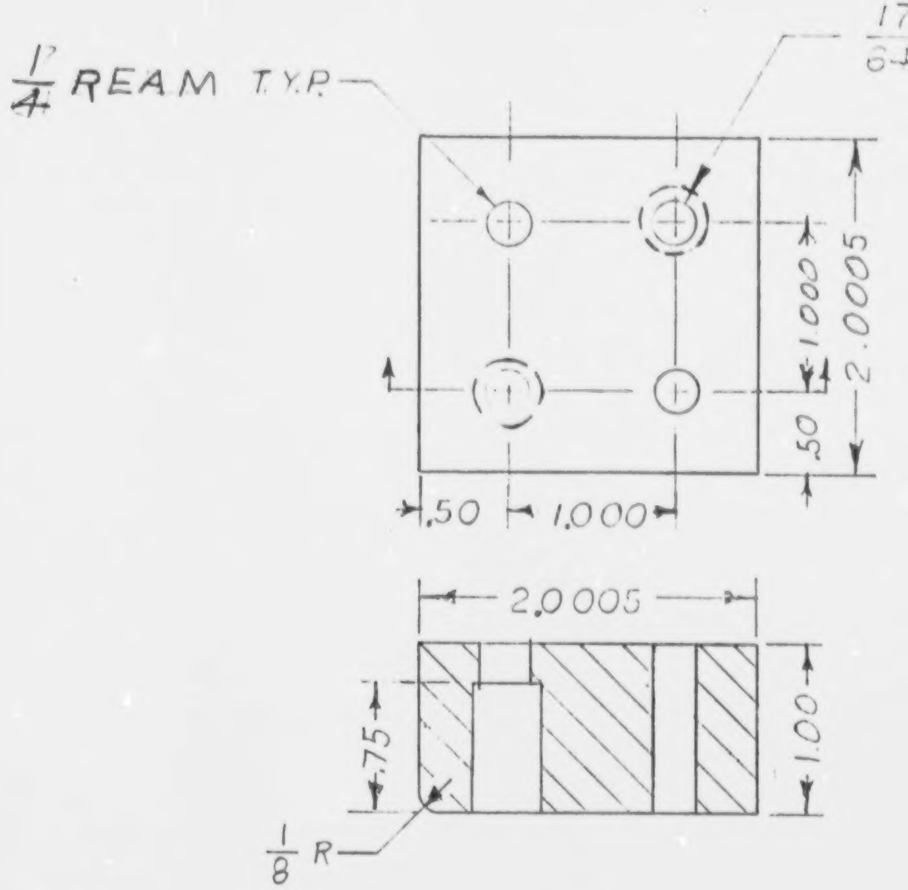
DRILL



MAT. TS

DIE BLOCK

NO.REQ. 1

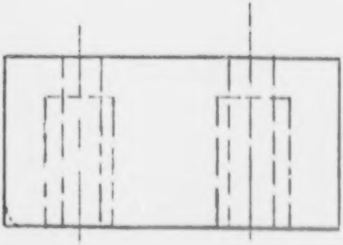

1/4 REAM TYP
17/6
1.000
2.0005
.50
.50
1.000
2.0005
.75
1.00
1/8 R

TOLERANCES
FRAC ± 1/64
.XX ± .005
.XXX ± .0005
.XXXX ± .00005

COURSE
TOOL & DIE

SCALE
FULL

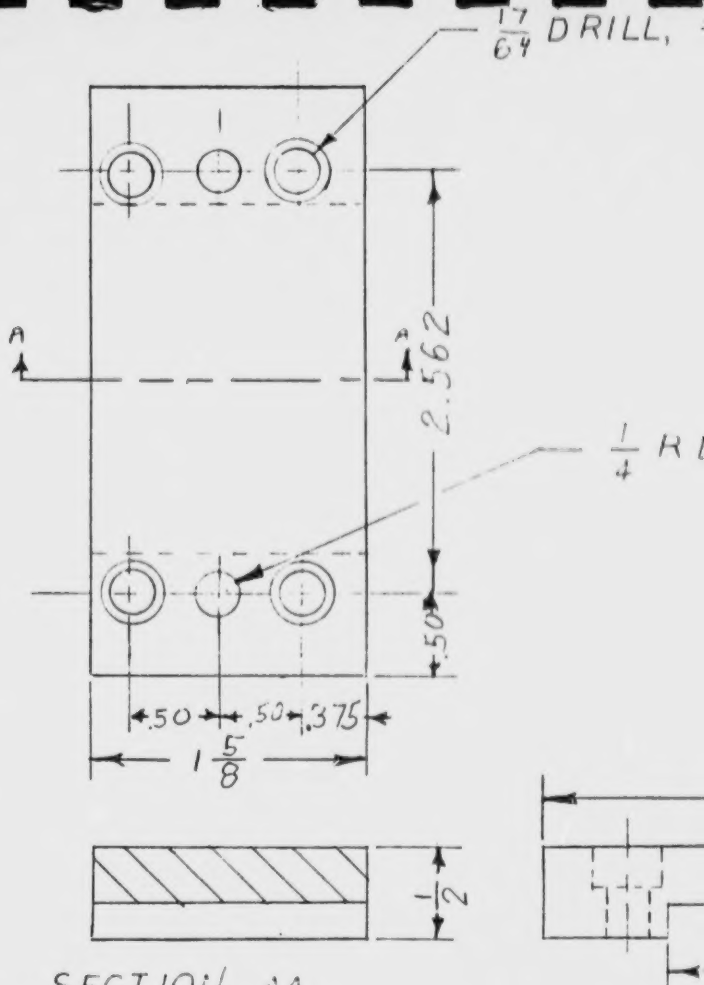
DRILL $\frac{5}{16}$ C'BORE TYP.



MATL. T.S.
NO. 1 E 2.1

PUNCH

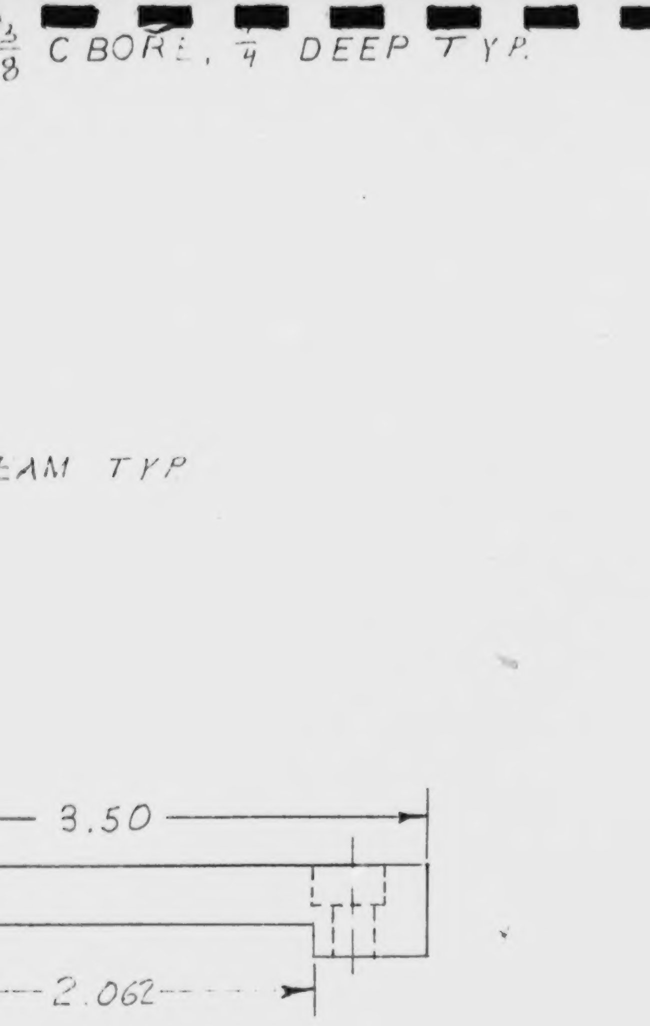
DR [illegible]


17/64 DRILL,
A
A
2.562
1/4 R
.50
.50
.50
.375
1 5/8
1/2

SECTION AA

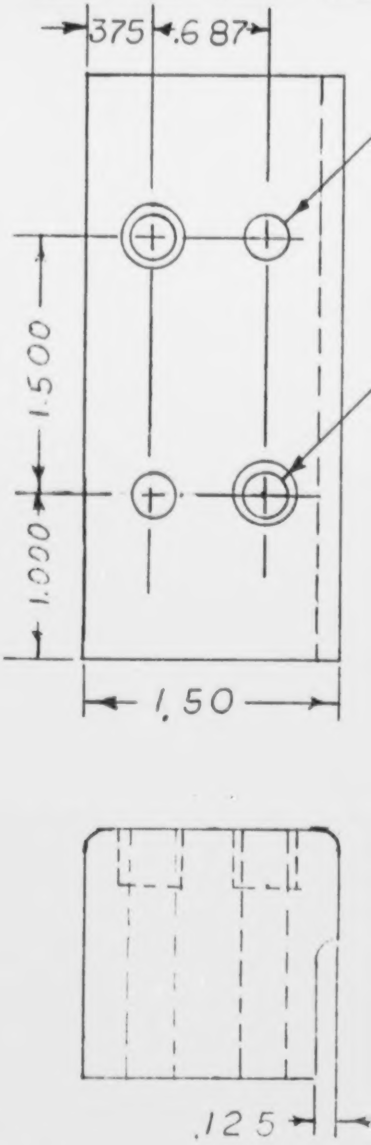
TOLERANCE
FRAC.±1/64
.X ± .05
.XX ± .005
.XXX ± .0005

COURSE TOOL&DIE	SCALE FULL



$\frac{3}{8}$ C BORE, $\frac{1}{4}$ DEEP TYP.
EAM TYP
3.50
2.062

MAT T.S.	STRIPPE	DY N
NO. REQ 1		C

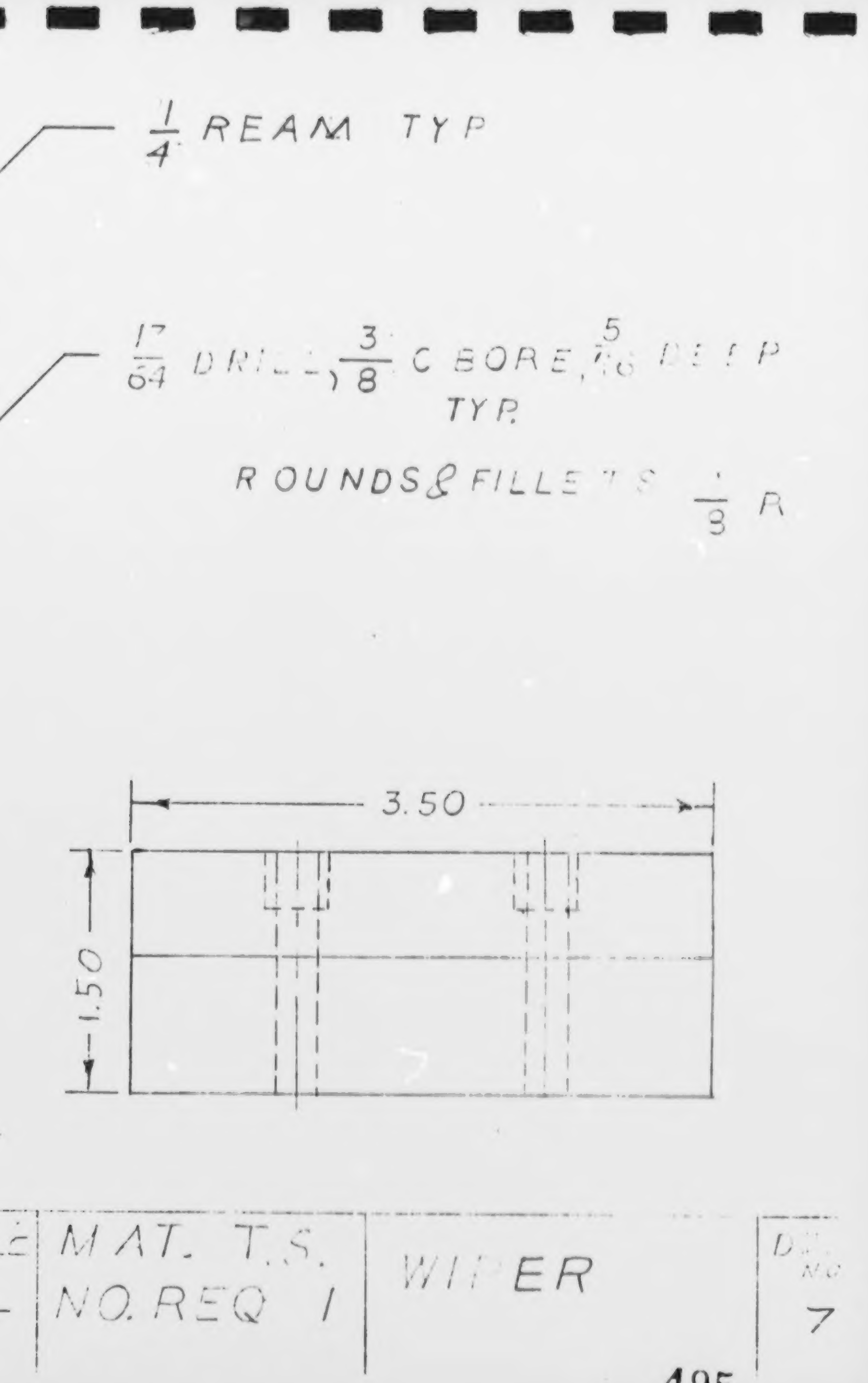


375
.687
1.500
1.000
1.50
.125

TOLERANCES
.XXX ± .0005
FRAC. ± 1/64

CORSE
TOOL & DIE

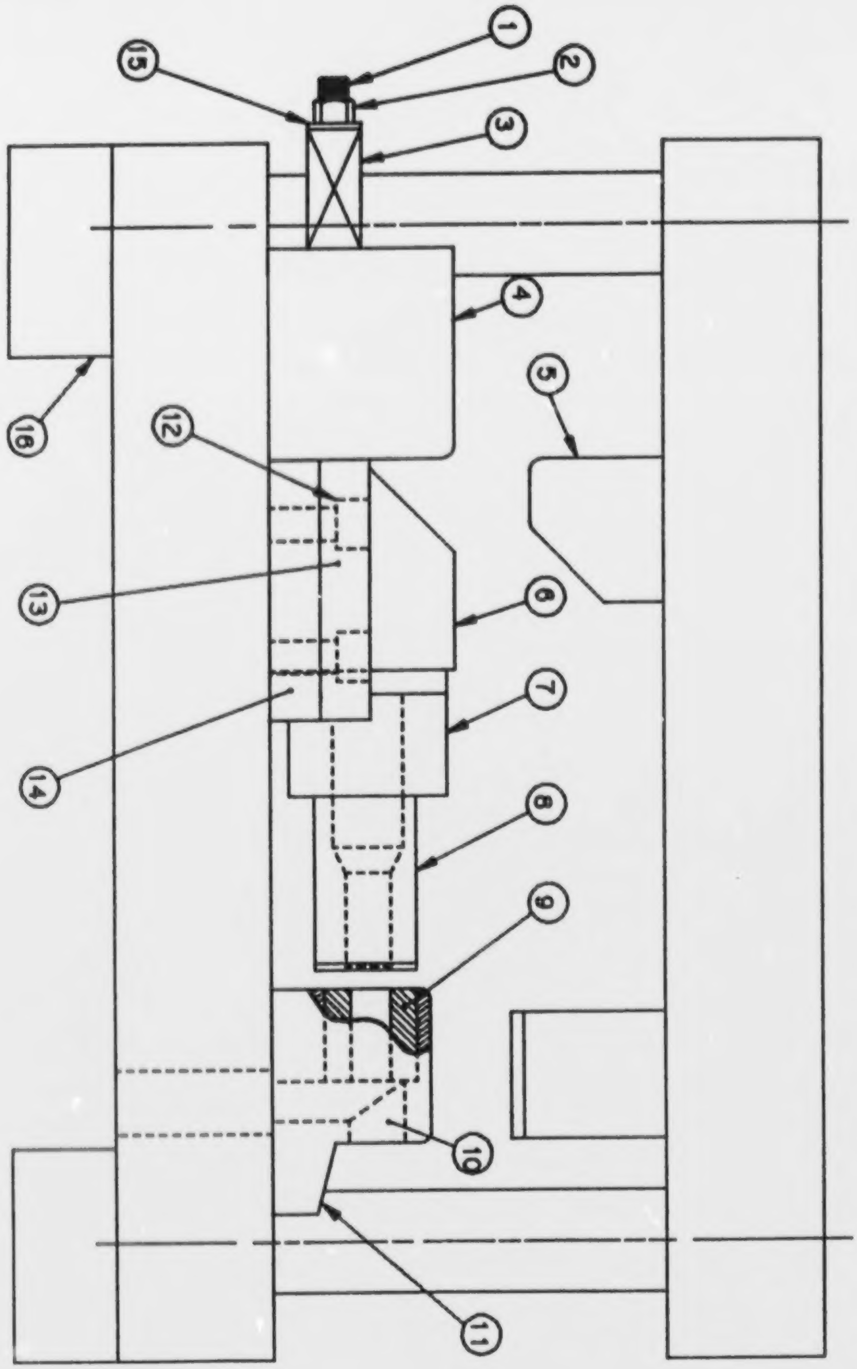
SCAL
FULL


1/4 REAM TYP
17/64 DRILL, 3/8 C BORE, 5/16 DEEP
TYP.
ROUNDS & FILLETS 1/8 R
3.50
1.50
MAT. T.S.
NO. REQ 1
WIPER
DWG NO
7

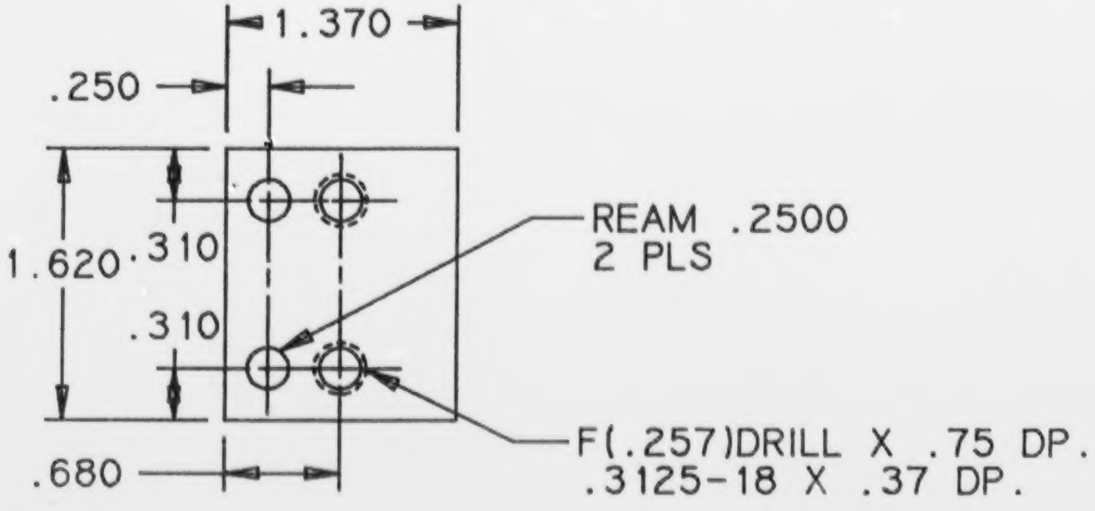
MILWAUKEE AREA TECHNICAL COLLEGE
Industrial Division
T&D Mkg TOOL AND DIE MAKING I
BILL OF MATERIAL

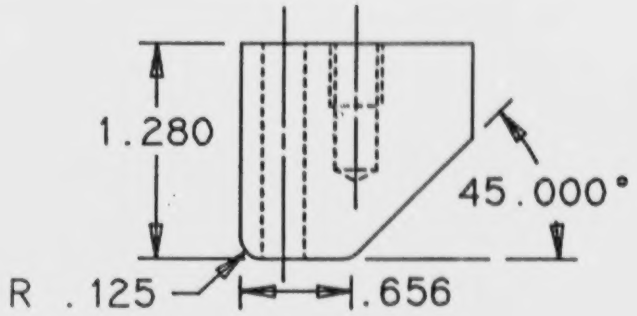
DET.	REQ.'D NO.	PART NAME	DESCRIPTION	MATERIAL
1	1	Threaded Rod	3/8-16 x 4" long	C.R.S.
2	1	Nut	3/8-16	
3	1	Spring	3/8 x 1-1 1/2"	C.R.S.
4	1	Heel Block	2 1/8 x 1 7/8 x 2 1/8	C.R.S.
5	1	Cam Driver	1 1/2 x 1 3/4 x 1 3/8	C.R.S.
6	1	Cam Slide	2 7/8 x 2 1/8 x 2	C.R.S.
7	1	Punch Holder	Supplied	
8	2	Nomar Stripper	1/2"I.D. x 1"0.0 x 1 1/2	Neuprene?
9	1	Button Die	Supplied	
10	1	Deflector Plug	3/8"Dia. x 3/4	C.R.S.
11	1	Mounting Block	3 1/2 x 2 1/4 x 1 5/8	C.R.S.
12	4	Hex Socket Cap Screw	5/16-18 x 1"	
13	2	Slide Keeper (GIB)	2 5/8 x 1 1/4 x 1/2	C.R.S.
14	2	Slide Keeper(GIB)	2 5/8 x 7/8 x 1/2	C.R.S.
15	1	Washer	3/8	
16	4	Blocks	Optional	C.R.S.
	4	Dowel Pin	1/4"x 3/4"	
	2	Dowel Pin	5/16"x 3/4"	
	2	Hex Socket Cap Screw	5/16-18 x 1"	
	2	" "	5/16-18 x 1 1/2"	
	4	" "	3/8-16 x 1"	
	2	" "	1/2-13 x 1 1/4"	

** Does not include fasteners for Detail # 16.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

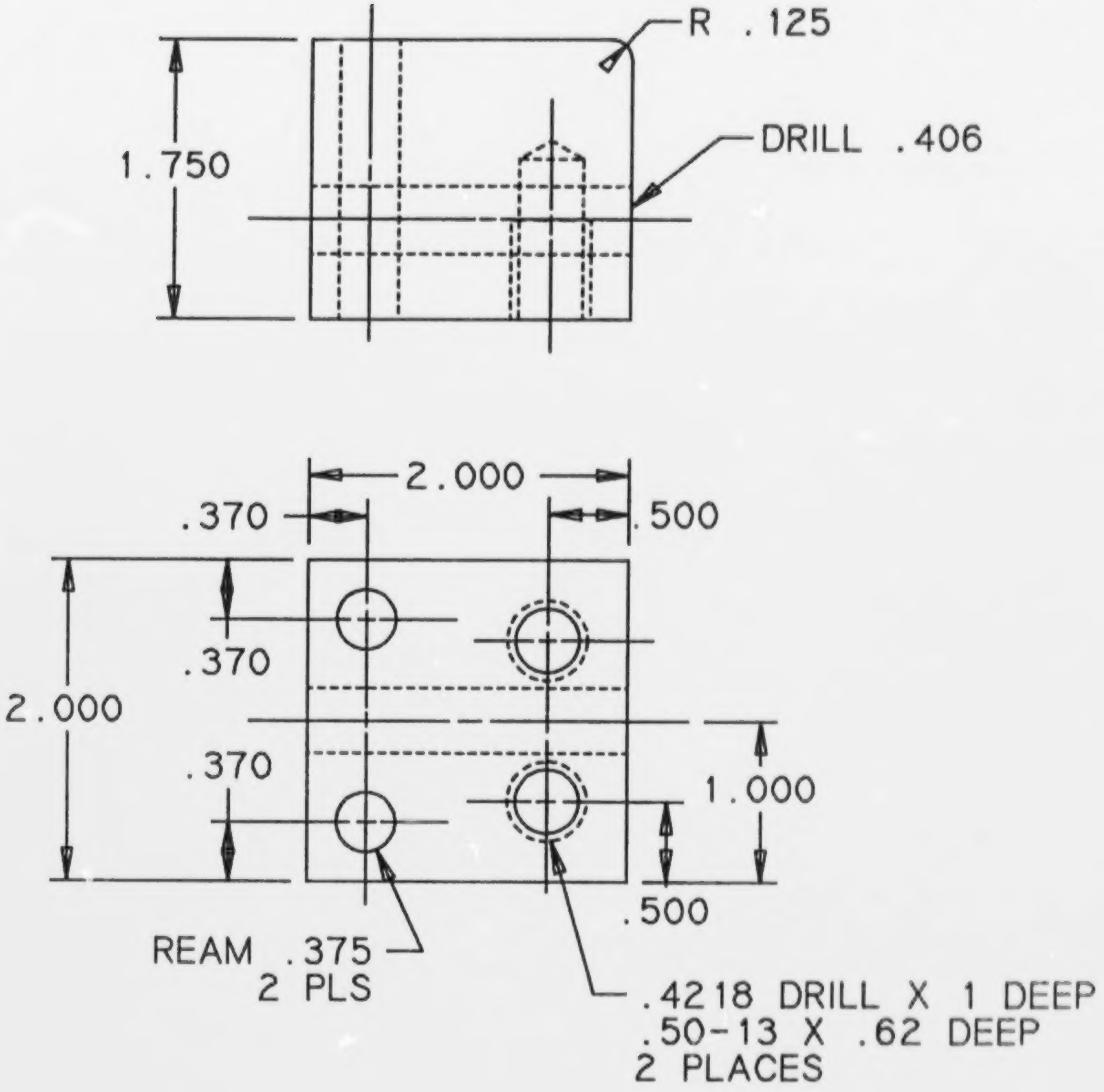
ANG ±	MATL. ____	TOOL AND DIE MAKING
FRAC ±	NO. REQ. ____	CAM,PIERCE DIE
XX ±	DET. NO. ____	SCALE:
XXX ±		SHEET 2 OF 10
XXXX ±		


1.370
.250
1.620
.310
.310
REAM .2500
2 PLS
F(.257)DRILL X .75 DP.
.3125-18 X .37 DP.
.680


1.280
45.000°
R .125
.656

F:CAMDRI2

ANG ±		MATL. C.R.S	TOOL AND DIE MAKING	
FRAC ±	1/32			
XX ±	.01	NO. REQ. 1	CAM DRIVER	
XXX ±	.002			
XXXX ±	.0005	DET. NO. 5	SCALE: FULL	SHEET 3 OF 10


R .125
DRILL .406
1.750
2.000
.370
.500
.370
2.000
.370
1.000
.500
REAM .375
2 PLS
.4218 DRILL X 1 DEEP
.50-13 X .62 DEEP
2 PLACES

H: HeeBlo1

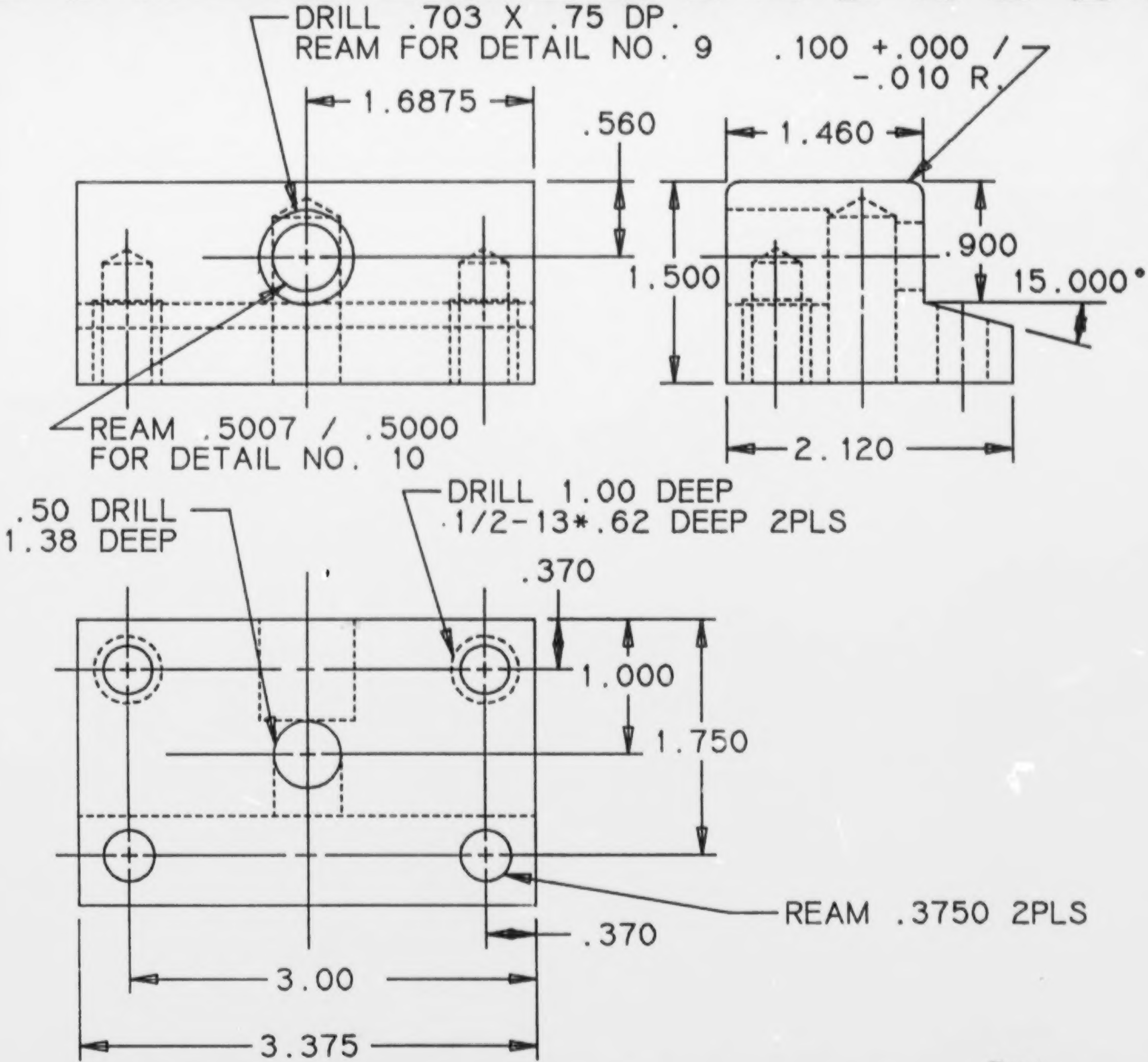
ANG ±	MATL. C.R.S.	TOOL AND DIE MAKING
FRAC ± 1/32	NO. REQ. 1	HEEL BLOCK
XX ± .01	DET. NO. 4	SCALE: FULL
XXX ± .002		SHEET 4 OF 10
XXXX ±		

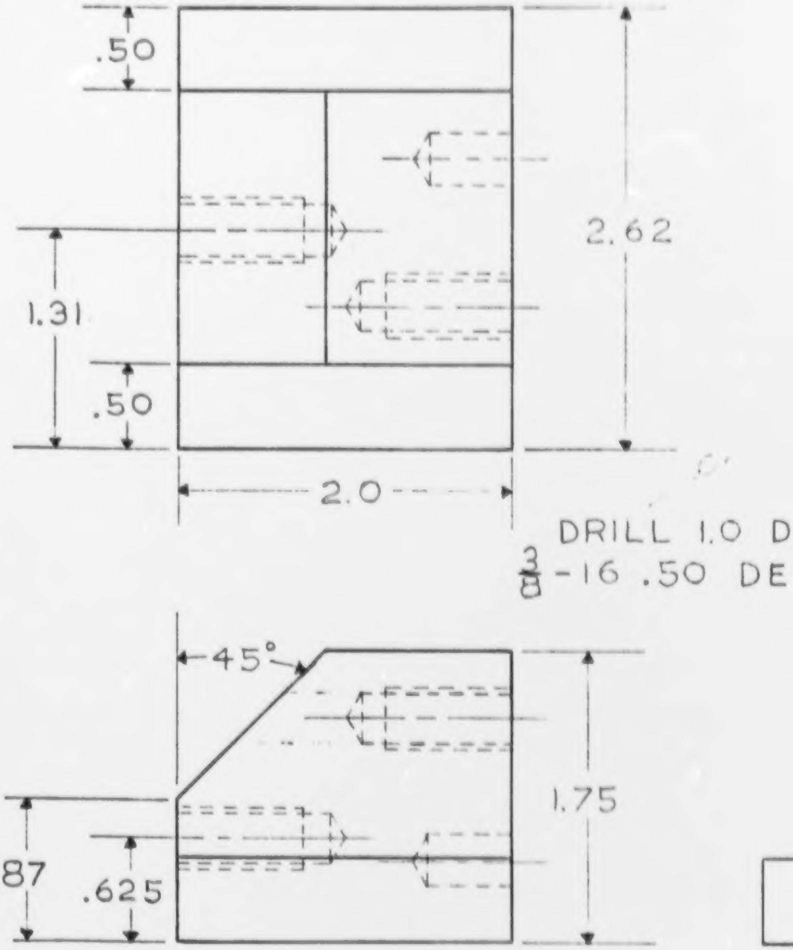
ANG ±	
FRAC ±	1/64
XX ±	.01
XXX ±	.002
XXXX ±	.0005

MATL. C.R.S.
NO. REQ. 1
DET. NO. 11

TOOL AND DIE MAKING
MOUNTING BLOCK

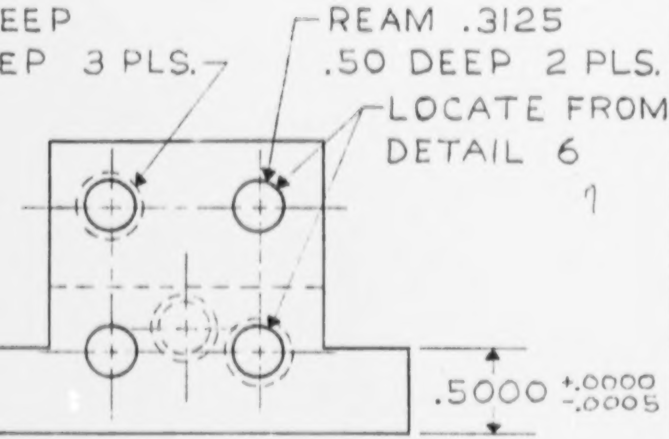
SCALE: FULL
SHEET 5 OF 10


DRILL .703 X .75 DP.
REAM FOR DETAIL NO. 9
.100 +.000 / -.010 R.
1.6875
.560
1.460
1.500
.900
15.000°
REAM .5007 / .5000
FOR DETAIL NO. 10
2.120
.50 DRILL
1.38 DEEP
DRILL 1.00 DEEP
1/2-13*.62 DEEP 2PLS
.370
1.000
1.750
REAM .3750 2PLS
.370
3.00
3.375


.50
2.62
1.31
.50
2.0
DRILL 1.0 D
$\frac{3}{8}$-16 .50 DE
45°
1.75
.87
.625

502

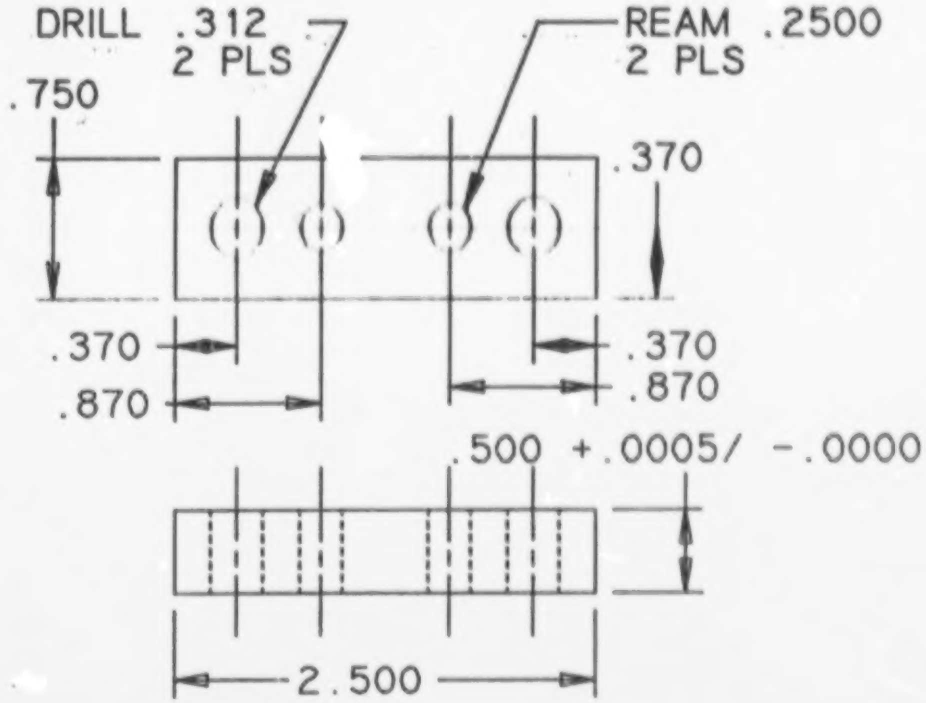
NOTE: REAM IN ASSEMBLY

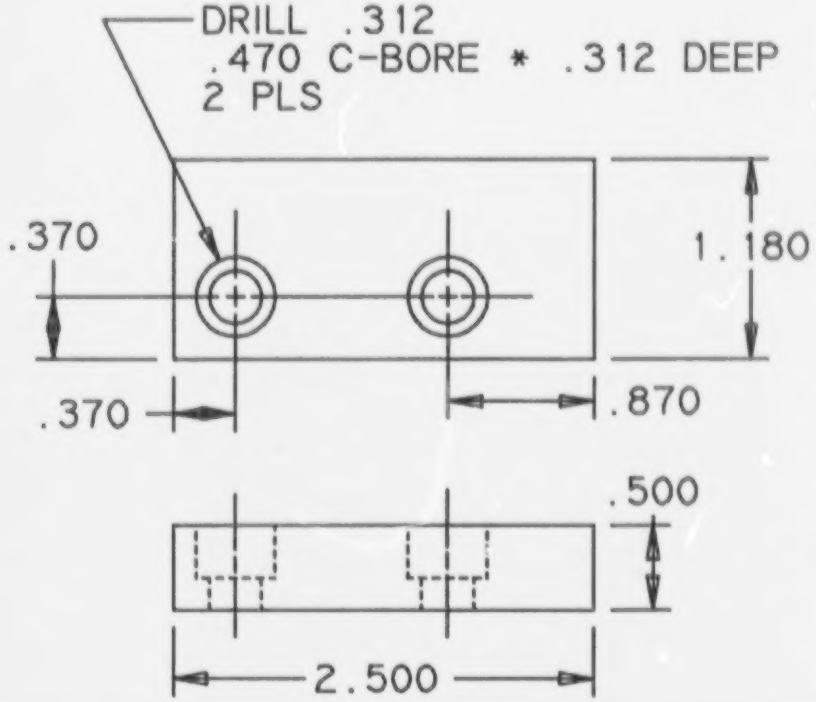

EEP
EP 3 PLS.
REAM .3125
.50 DEEP 2 PLS.
LOCATE FROM
DETAIL 6
7
.5000 +.0000 -.0005

TOOL AND DIE MAKING
CAM SLIDE
Scale: FULL
Sh 6 of 10

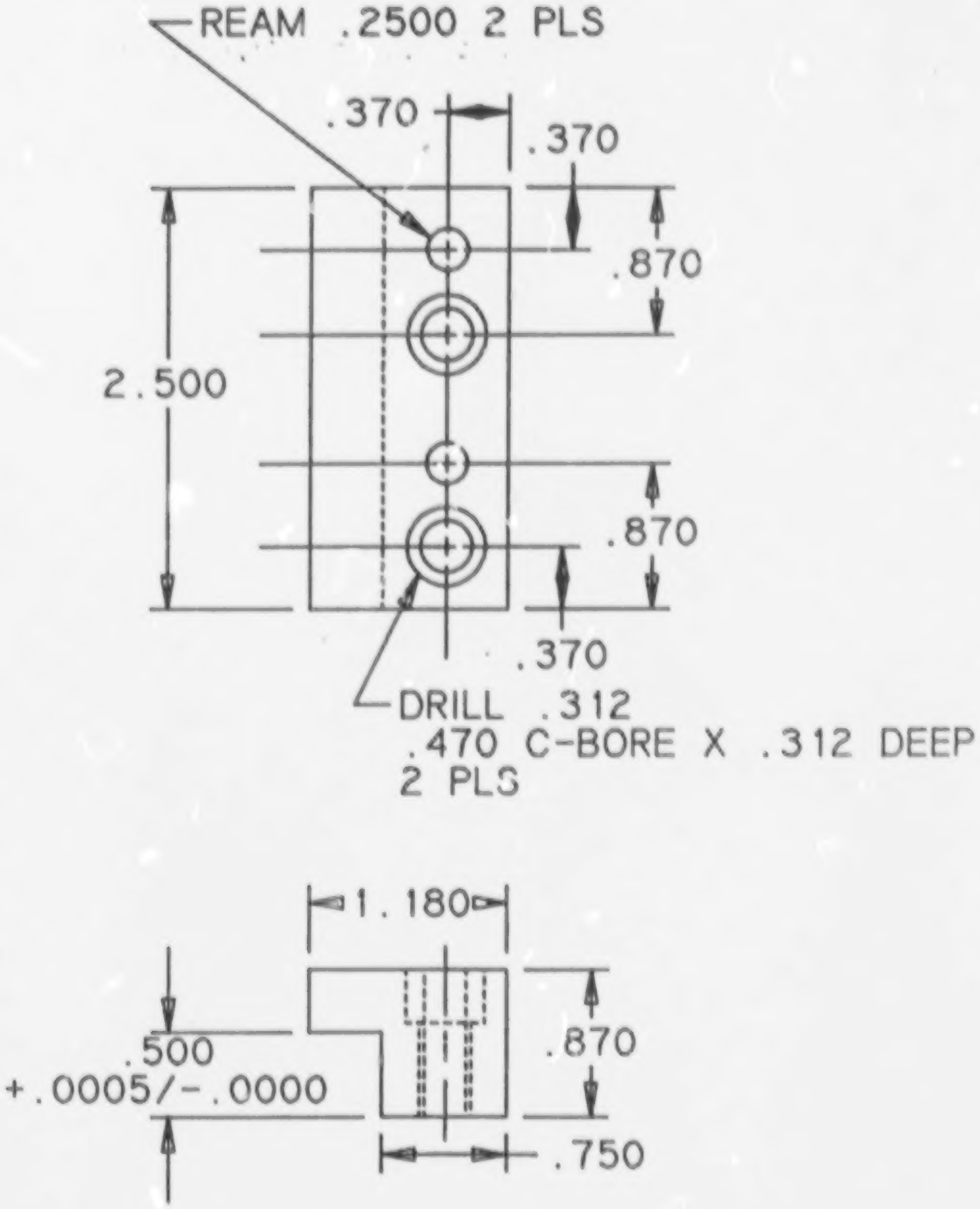
MATL: CRS
NO. REQ. 1
DET. NO. 6

ANG ±
FRAC ±
XX ± .01
XXX ± .002
XXXX ± .0005

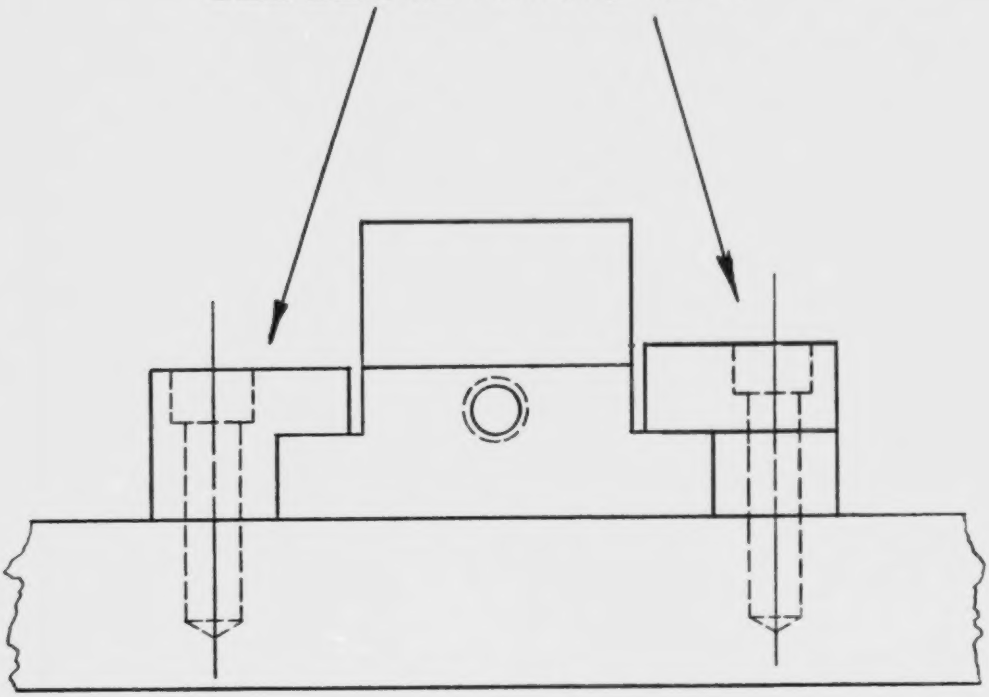

DRILL .312
2 PLS
REAM .2500
2 PLS
.750
.370
.370
.370
.870
.870
.500 +.0005/ -.0000
2.500


DRILL .312
.470 C-BORE * .312 DEEP
2 PLS
.370
1.180
.370
.870
.500
2.500

ANG ±		MATL. C.R.S.	TOOL AND DIE MAKING
FRAC ±			
XX ±	.01	NO. REQ. 2 EA.	SLIDE KEEPERS
XXX ±	.002	DET. NO. 12+13	SCALE: FULL
XXXX ±	.0005		SHEET 7 OF 10

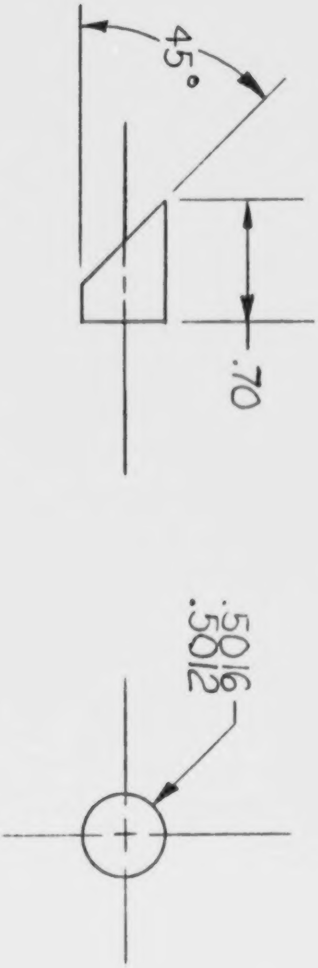

REAM .2500 2 PLS
.370
.370
.870
2.500
.870
.370
DRILL .312
.470 C-BORE X .312 DEEP
2 PLS
1.180
.500
+.0005/-.0000
.870
.750

ANG ±	MATL. C.R.S.	TOOL AND DIE MAKING	
FRAC ±			
XX ± .01	NO. REQ. 2	SLIDE KEEPERS	
XXX ± .002	DET. NO. SUB.	SCALE: FULL	SHEET 8 OF 10
XXXX ± .0005	FOR 12+13		



NOTE:
2 KEEPER CHOICES -
SEE DETAIL PRINTS 12+13

ANG ± ____ FRAC ± ____ XX ± ____ XXX ± ____ XXXX ± ____	MATL: ____ NO. REQ. ____ DET. NO. ____	TOOL AND DIE MAKING SLIDE AND KEEPERS ASSY Scale: FULL — Sh 9 of 10


45°
.70
.5016
.5012

ANG ±
FRAC ±
XX ± .01
XXX ±
XXXX ±

MATL: C.R.S.
NO. REQ. 1
DET. NO. 10

TOOL AND DIE MAKING

DEFLECTOR PLUG

Scale: FULL
Sh 10 of 10

A' DEFPLUG

ITEM	REQ	DESCRIPTION	MATL
2	2	1/4 X 1 3/16 X 2 9/16	M.S.
4	2	2 1/16 X 1 15/16 X 3 1/16	M.S.
8	1	2 1/16 X 1 13/16 X 3 1/16	M.S.
6	1	1 1/16 X 1 1/16 X 3 9/16	M.S.

A' BFDIPL

ANG ± ____
FRAC ± ____
XX ± ____
XXX ± ____
XXXX ± ____

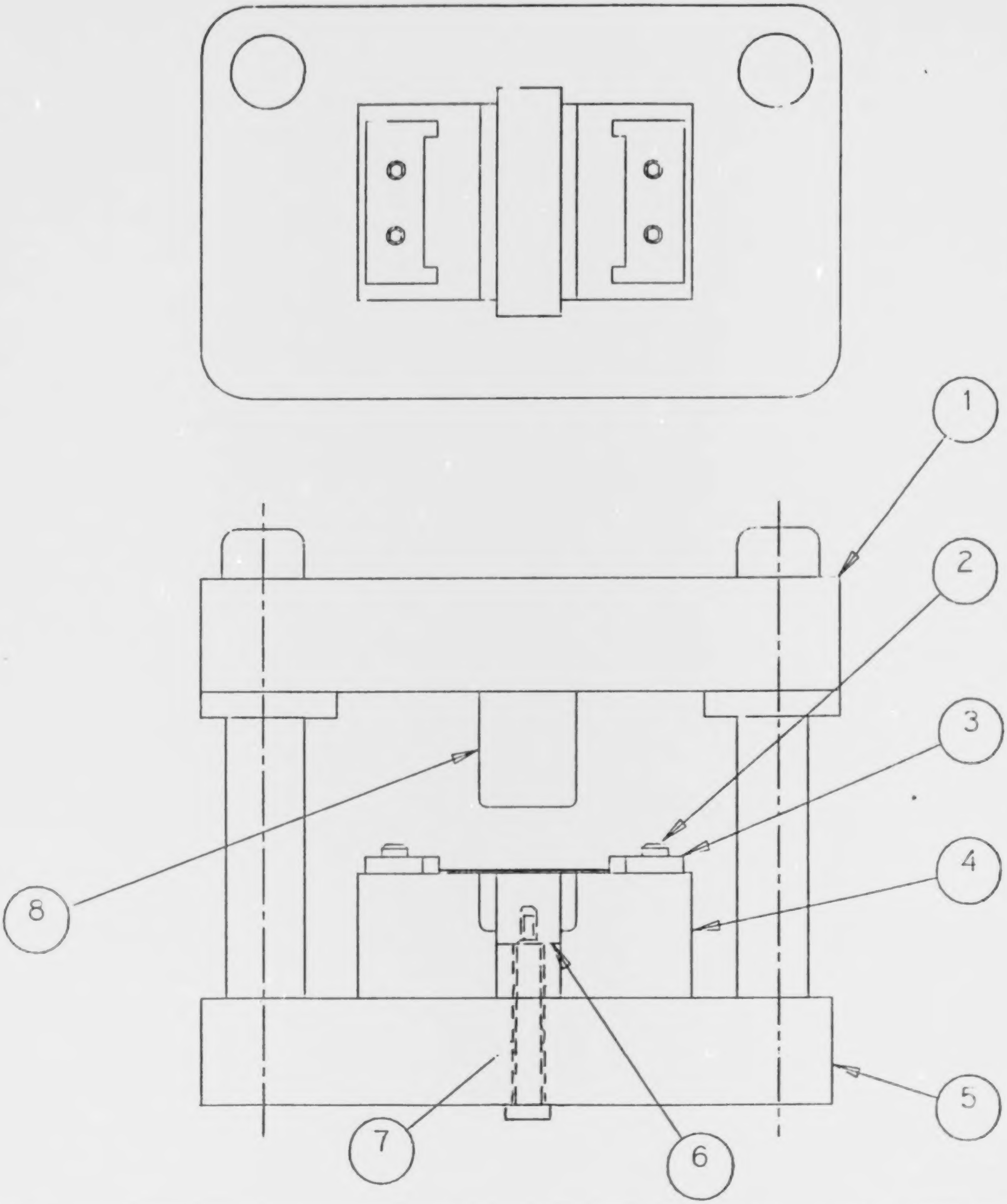
MATL: ________
NO. REQ. ________
DET. NO. ________

TOOL AND DIE MAKING

BENDING DIE

Scale:

Sh 1 of 7



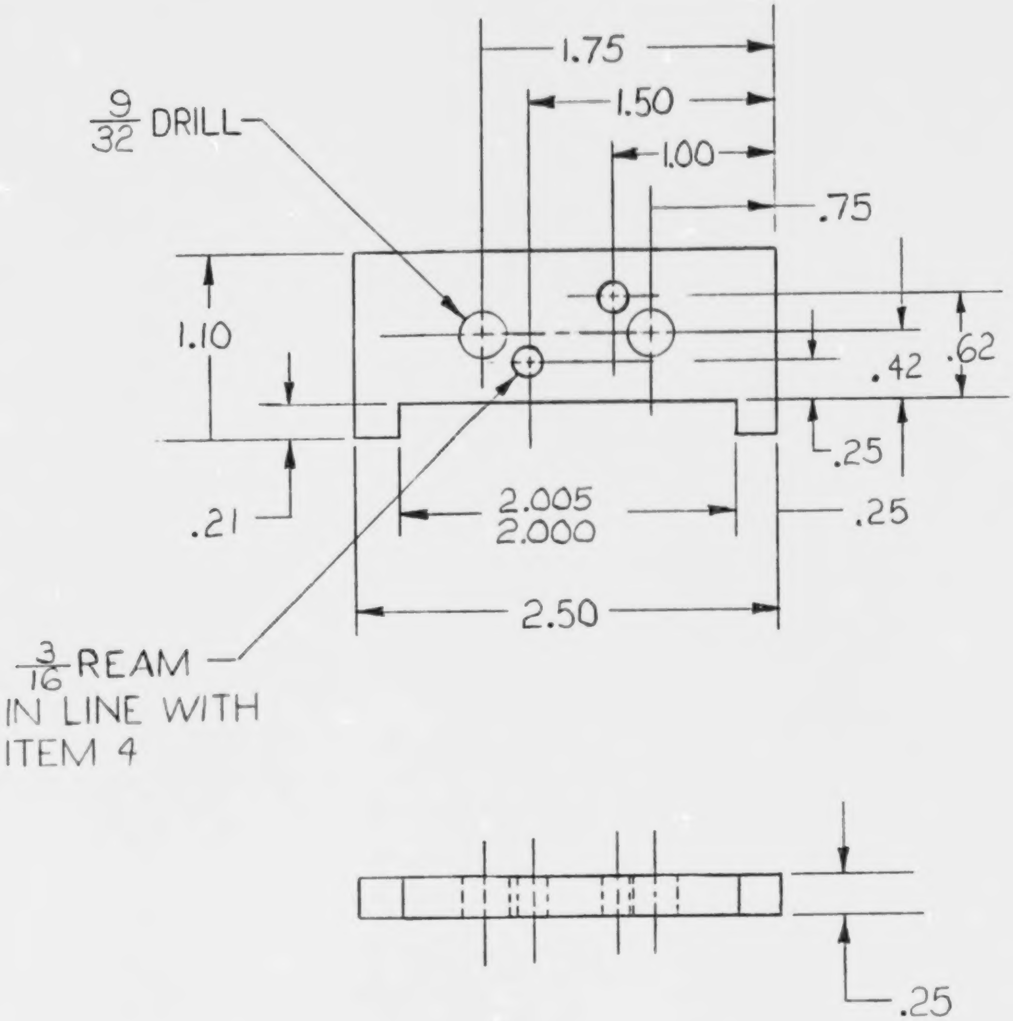
ANG ±
X ±
XX ±
XXX ±
XXXX ±

MATL:
NO. REQ.
DET. NO.

TOOL AND DIE MAKING

BENDING DIE

Scale: .5" = 1"
Sh 2 of 7


9/32 DRILL
1.75
1.50
1.00
.75
1.10
.42
.62
.25
.21
2.005
2.000
.25
2.50
3/16 REAM
IN LINE WITH
ITEM 4
.25

ANG ± 1°
FRAC ± 1/64
XX ± .01
XXX ± .002
XXXX ± ——

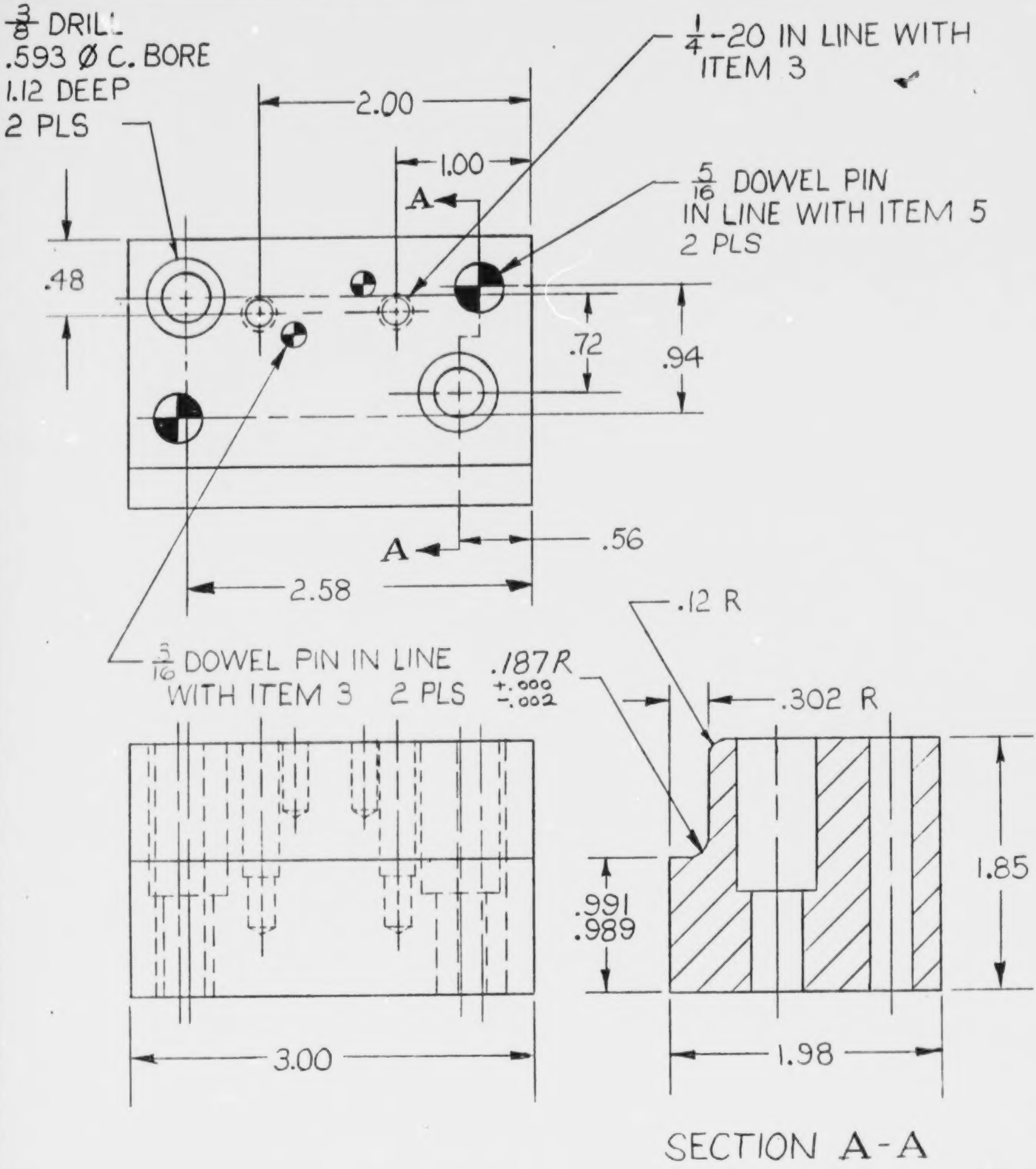
MATL: C.R.S.
NO. REQ. 2
DET. NO. 3

TOOL AND DIE MAKING

GAGE

Scale: FULL

Sh 3 of 7


3/8 DRILL
.593 Ø C. BORE
1.12 DEEP
2 PLS
1/4-20 IN LINE WITH ITEM 3
2.00
1.00
A
5/16 DOWEL PIN
IN LINE WITH ITEM 5
2 PLS
.48
.72
.94
A
.56
2.58
.12 R
5/16 DOWEL PIN IN LINE
WITH ITEM 3 2 PLS
.187R
+.000
-.002
.302 R
1.85
.991
.989
3.00
1.98
SECTION A-A

ANG ±
FRAC ±
XX ± .01
XXX ± .002
XXXX ±

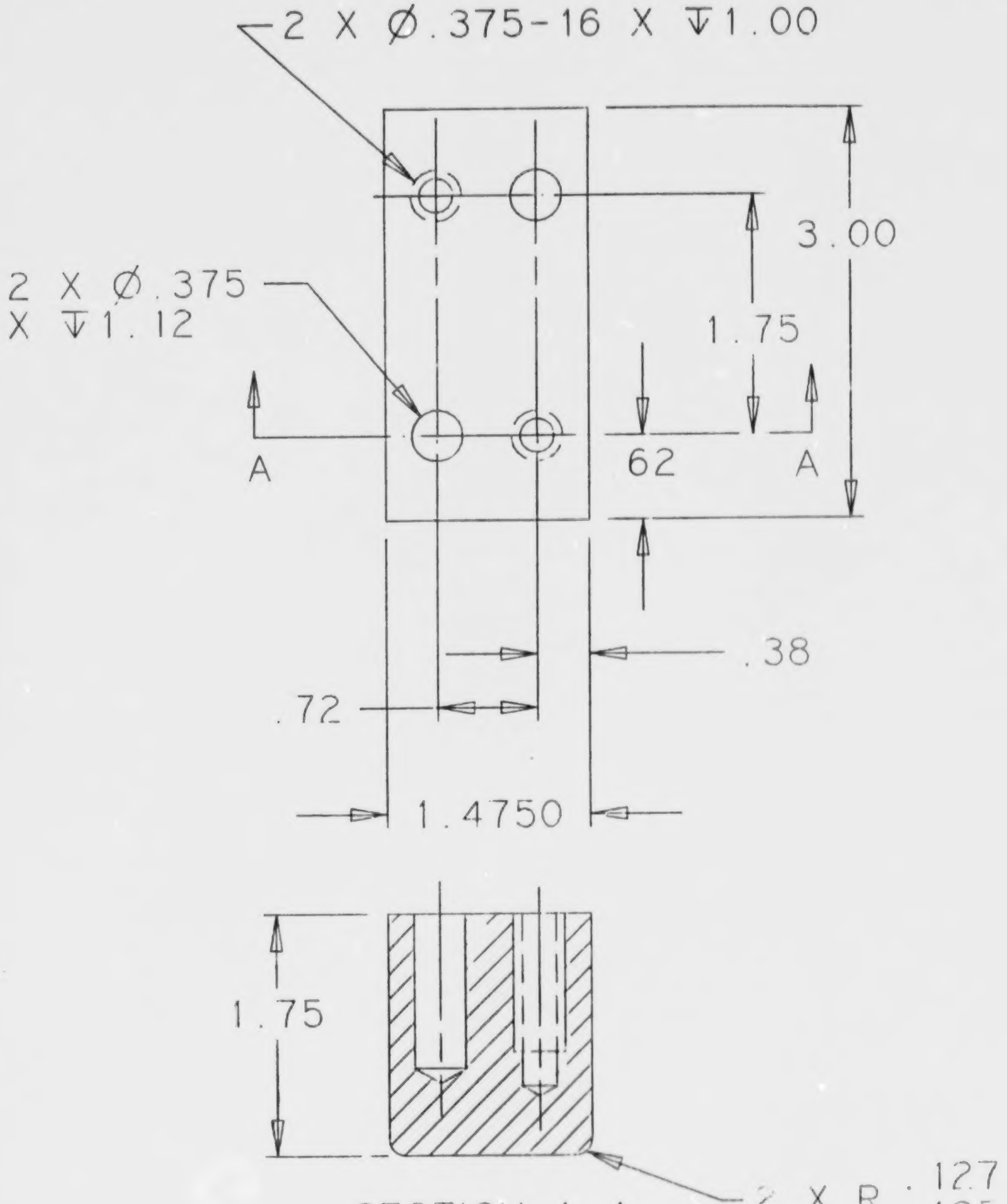
MATL: C.R.S.
NO. REQ. 2
DET. NO. 4

TOOL AND DIE MAKING

DIE BLOCK A: DIEBLO4

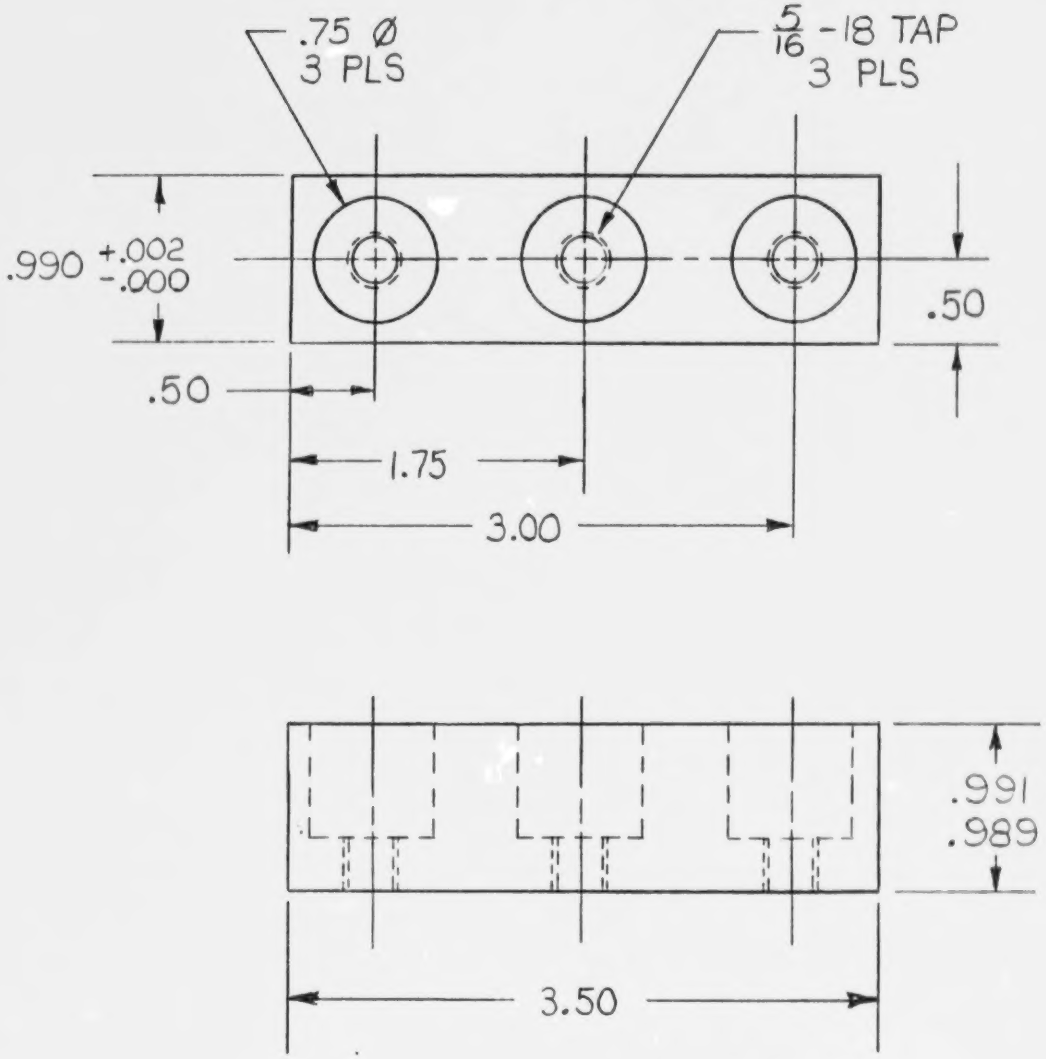
Scale: FULL

Sh 4 of 7


2 X Ø.375-16 X ↧1.00
2 X Ø.375
X ↧1.12
3.00
1.75
62
A
A
.38
.72
1.4750
1.75
2 X R .127
.125

SECTION A-A

ANG ±		MATL: C.R.S.	TOOL AND DIE MAKING	
X ±		NO. REQ. 1	PUNCH	
XX ±	.01	DET. NO. 8		
XXX ±	.002			
XXXX ±	.0005		Scale: FULL	Sh 5 of 7


.75 Ø
3 PLS
5/16 -18 TAP
3 PLS
.990 +.002 -.000
.50
.50
1.75
3.00
.991
.989
3.50

ANG ±
FRAC ±
XX ± .01
XXX ± .002
XXXX ±

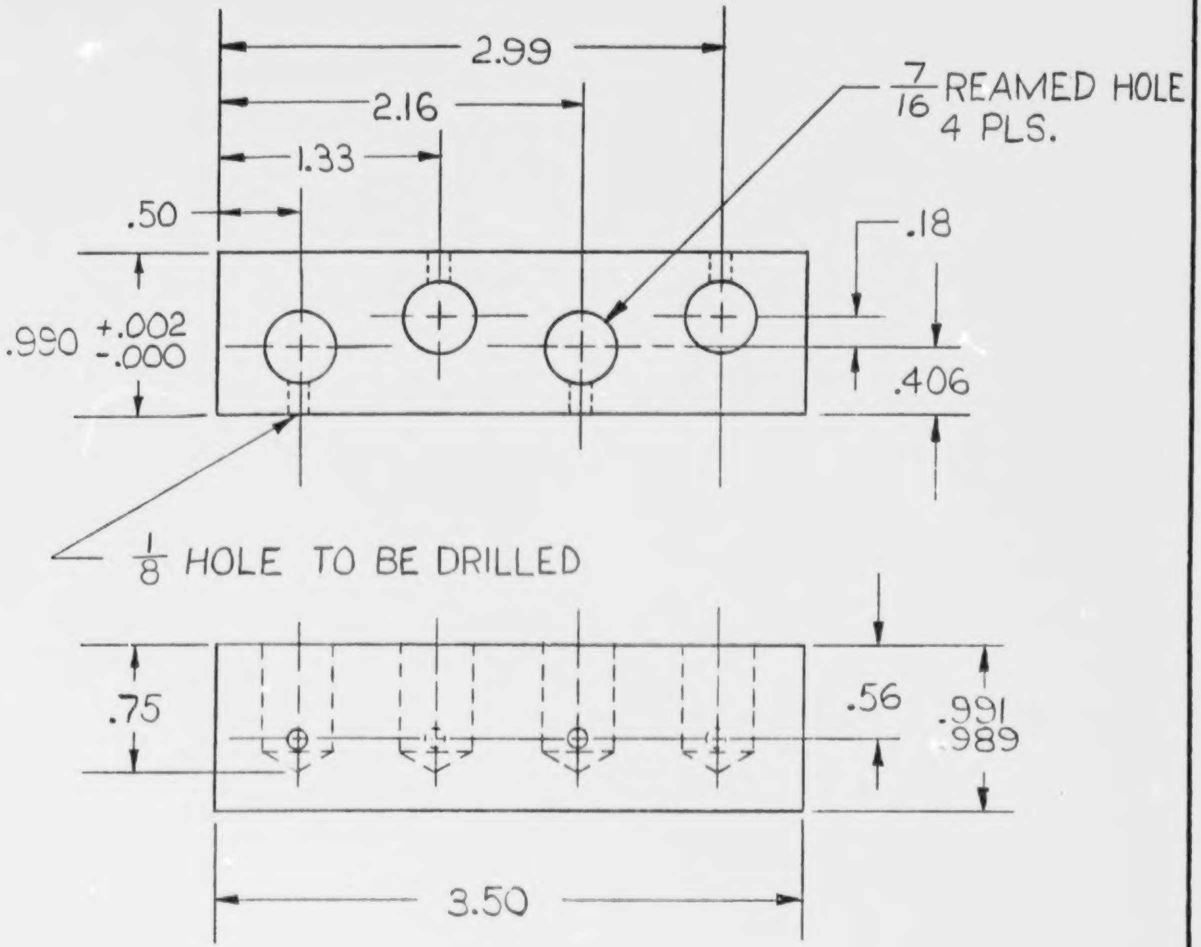
MATL: C.R.S.
NO. REQ. 1
DET. NO. 6

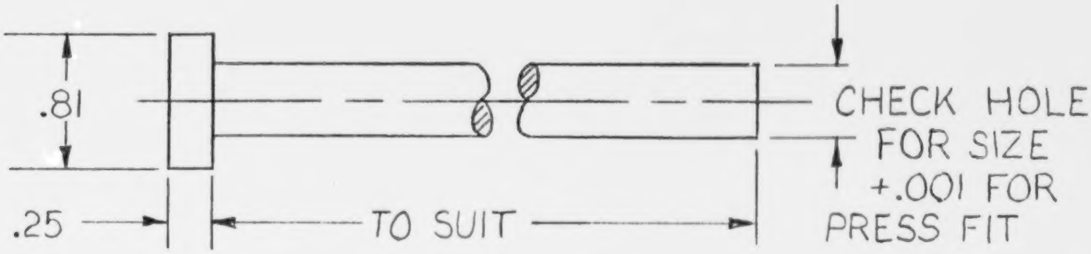
TOOL AND DIE MAKING

PAD

Scale: FULL

Sh 6 of 7


2.99
2.16
1.33
.50
7/16 REAMED HOLE 4 PLS.
.18
.990 +.002 -.000
.406
1/8 HOLE TO BE DRILLED
.75
.56
.991
.989
3.50


.81
CHECK HOLE FOR SIZE +.001 FOR PRESS FIT
.25
TO SUIT

ANG ± 1°
FRAC ±
XX ± .01
XXX ± .002
XXXX ±

MATL: C.R.S.
NO. REQ. 1
DET. NO. 6

TOOL AND DIE MAKING

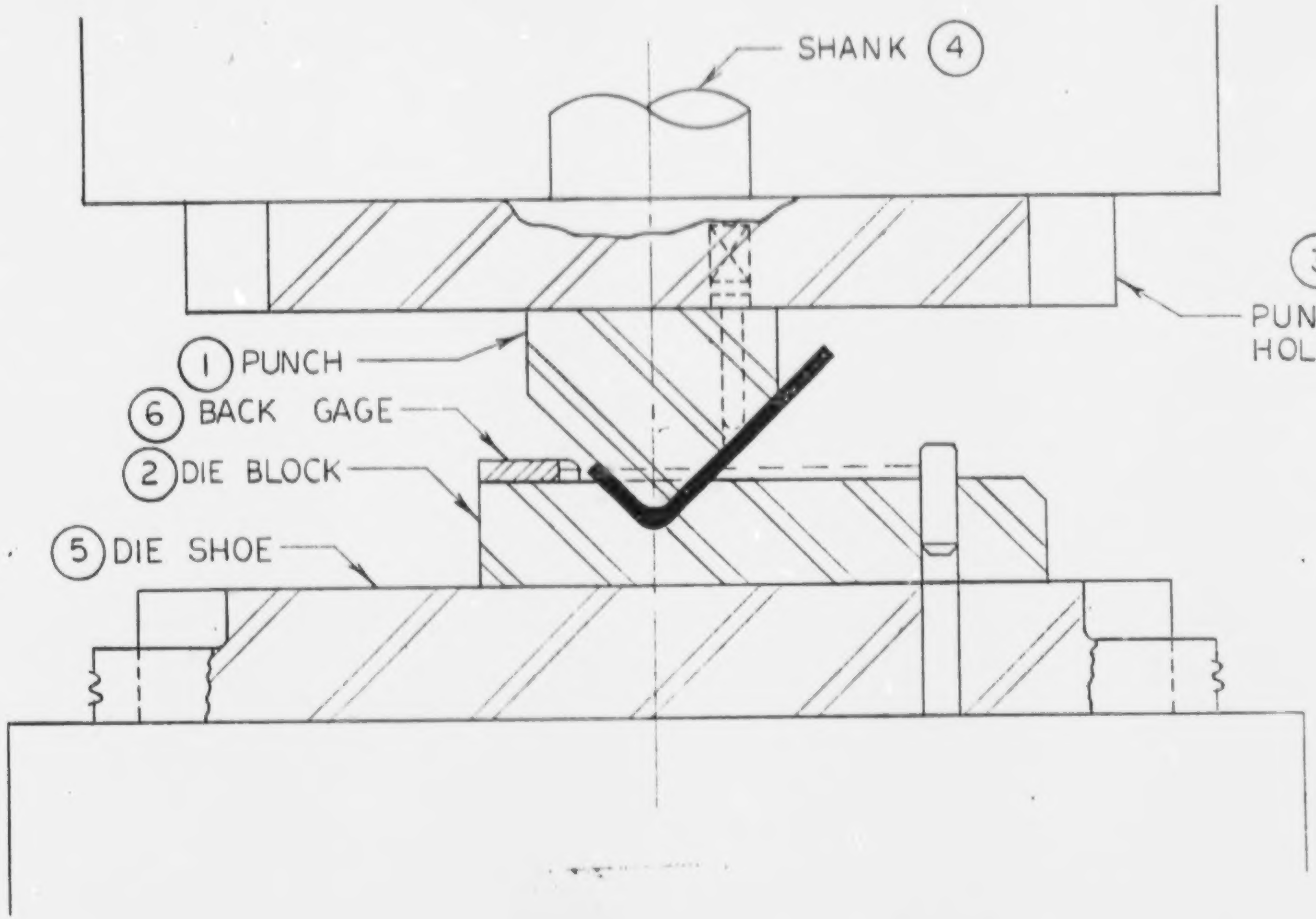
PAD
PIN

Scale: FULL
Sh 7 of 7

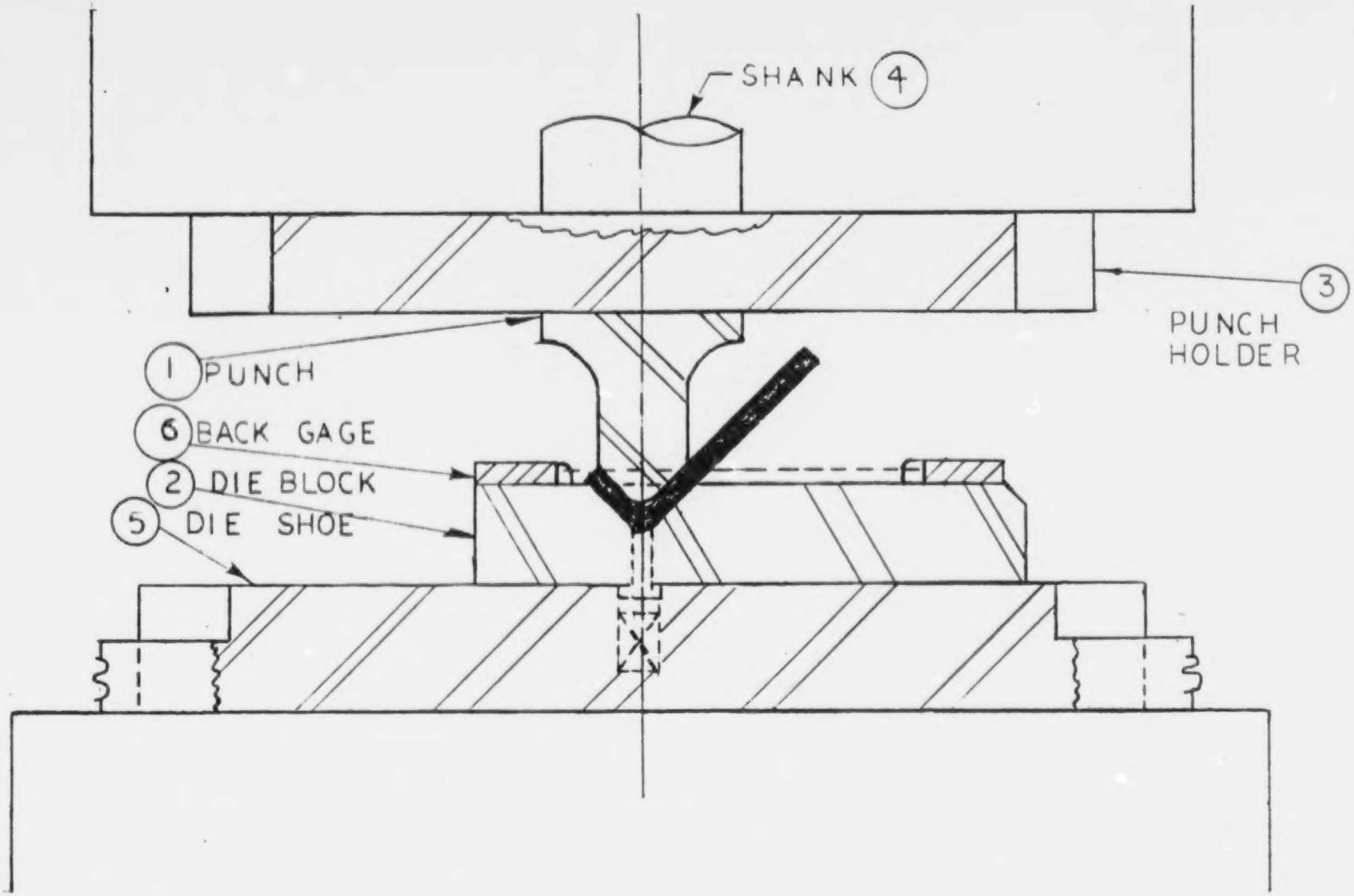
BENDING DIE

BILL OF MATERIAL

No.	NAME	QUAN.	MAT.	SIZE	REMARKS
1	Punch	1	C. H. T. S	RC. 60-62	2 x 2 x 2
2	Die Block	1	C. H. T. S	RC. 60-62	4 x 5 x 1
3	Punch Holder	1			Use previous design
4	Shank	1			Use previous design
5	Die Shoe	1			Use previous design
6	Back Gage	1	C. R. S.	1/4	1/4 x 1 x 4
1B	Punch	1	TS		1 3/4 x 1 3/4 x 2
8					
9	Dowels	5			5/16
10	Screws	6			5/16 18 NC
11	Screws	3			1/4 20 NC

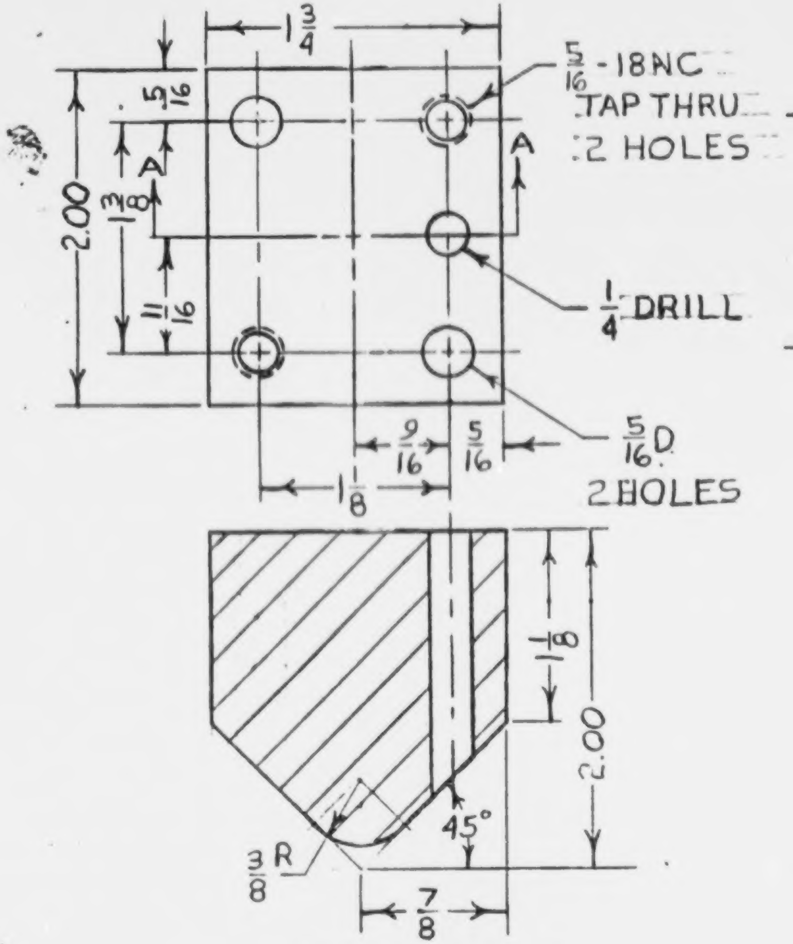

SHANK ④
③ PUNCH HOLDER
① PUNCH
⑥ BACK GAGE
② DIE BLOCK
⑤ DIE SHOE

COURSE		PROBLEM	DATE	MILWAUKEE VOCATIONAL TECHNICAL AND ADULT SCHOOLS
TOLERANCES	DAY	SHEETS	DRAWN		NAME OF PLATE BENDING DIE
	MATERIAL	TRACED		
		CHECKED		SCALE NONE	NO.


SHANK ④
③ PUNCH HOLDER
① PUNCH
⑥ BACK GAGE
② DIE BLOCK
⑤ DIE SHOE

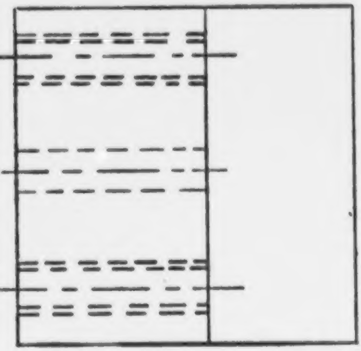
COURSE			PROBLEM	DATE	MILWAUKEE VOCATIONAL TECHNICAL AND ADULT SCHOOLS
TOLERANCES	DAY	SHEETS	DRAWN		NAME OF PLATE BENDING DIE
	MATERIAL		TRACED		
			CHECKED		SCALE NONE · NO.

30:G3:70A 26M 2-67 844 IP A-94 (TRACING PAPER)


1 3/4
5/16
2.00
1 3/8
11/16
A
A
5/16 - 18NC
TAP THRU
2 HOLES
1/4 DRILL
9/16
5/16
5/16 D.
2 HOLES
1 1/8
1 1/8
2.00
45°
3/8 R
7/8

SECTION A-A

COURSE			PROBLEM
TOLERANCES	DAY	SHEETS	DRAWN
	MATERIAL		TRACED
			CHECKED



DATE

MILWAUKEE VOCATIONAL TECHNICAL AND ADULT SCHOOLS

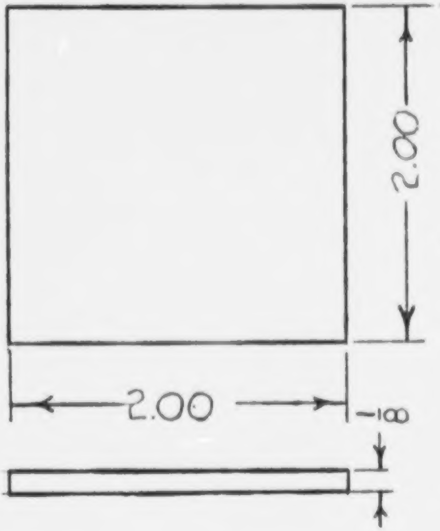
NAME OF PLATE

PUNCH

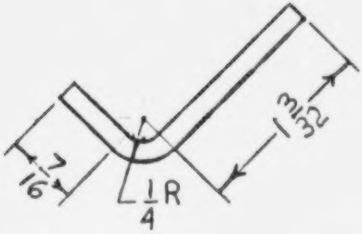
SCALE FULL

NO.

30:G3:70A 26M 2-67/844 1F A-84 (TRACING PAPER)



COURSE			**PROBLEM**
TOLERANCES	**DAY**	**SHEETS**	**DRAWN**
	MATERIAL		**TRACED**
			CHECKED


7/16
1 13/32
1/4 R

ATE

MILWAUKEE VOCATIONAL TECHNICAL AND ADULT SCHOOLS

NAME OF PLATE

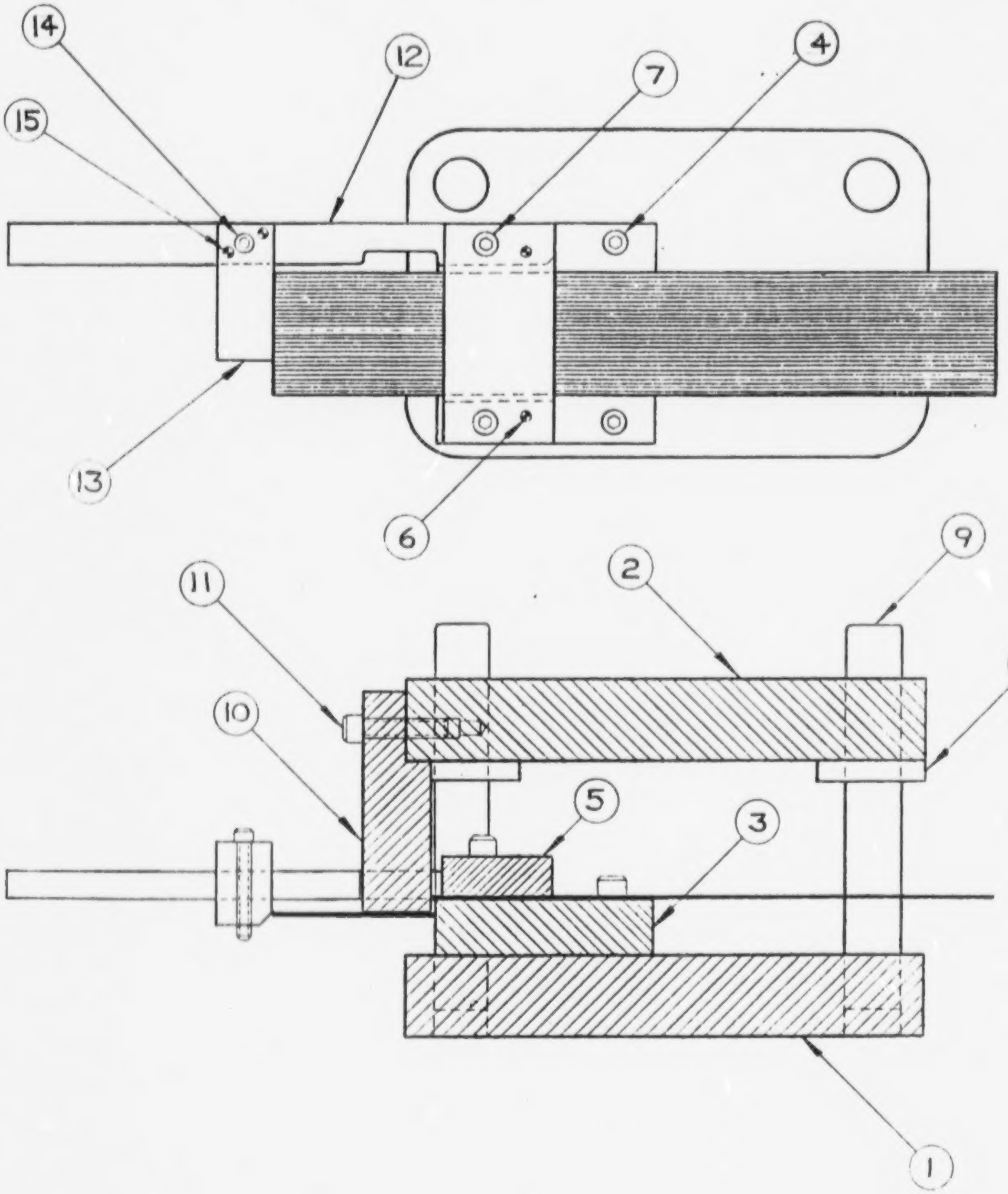
SCALE FULL

NO.

BILL OF MATERIALS

No.	Part Name	Quan.	Description
1	Die Shoe	1	
2	Punch Shoe	1	
3	Die Block	1	
4	Bolt	2	$\frac{3}{8}$"-16 UNC × 1$\frac{3}{4}$" Socket Head Cap Screw
5	Stripper	1	
6	Dowel Pin	2	
7	Bolt	2	$\frac{3}{8}$"-16 UNC. × 2$\frac{1}{2}$" Socket Head Cap Screw
8	Bushing	2	
9	Guidepost	2	
10	Punch	1	
11	Bolt	2	$\frac{3}{8}$"-16 UNC × 1$\frac{1}{2}$" Socket Head Cap Screw
12	Back Guage	1	
13	Stop	1	
14	Bolt	1	$\frac{1}{4}$"-20 UNC × 1$\frac{3}{4}$" Socket Head Cap Screw
15	Dowel Pin	2	

ANG ± ____ FRAC ± ____ XX ± ____ XXX ± ____ XXXX ± ____	MATL: ____ NO. REQ. ____ DET. NO. ____	TOOL AND DIE MAKING BILL OF MATERIALS
		Scale:
		Sh 1 of 7


14
12
4
7
15
13
6
9
2
11
8
10
5
3
1

ANG ± _____
FRAC ± _____
XX ± _____
XXX ± _____
XXXX ± _____

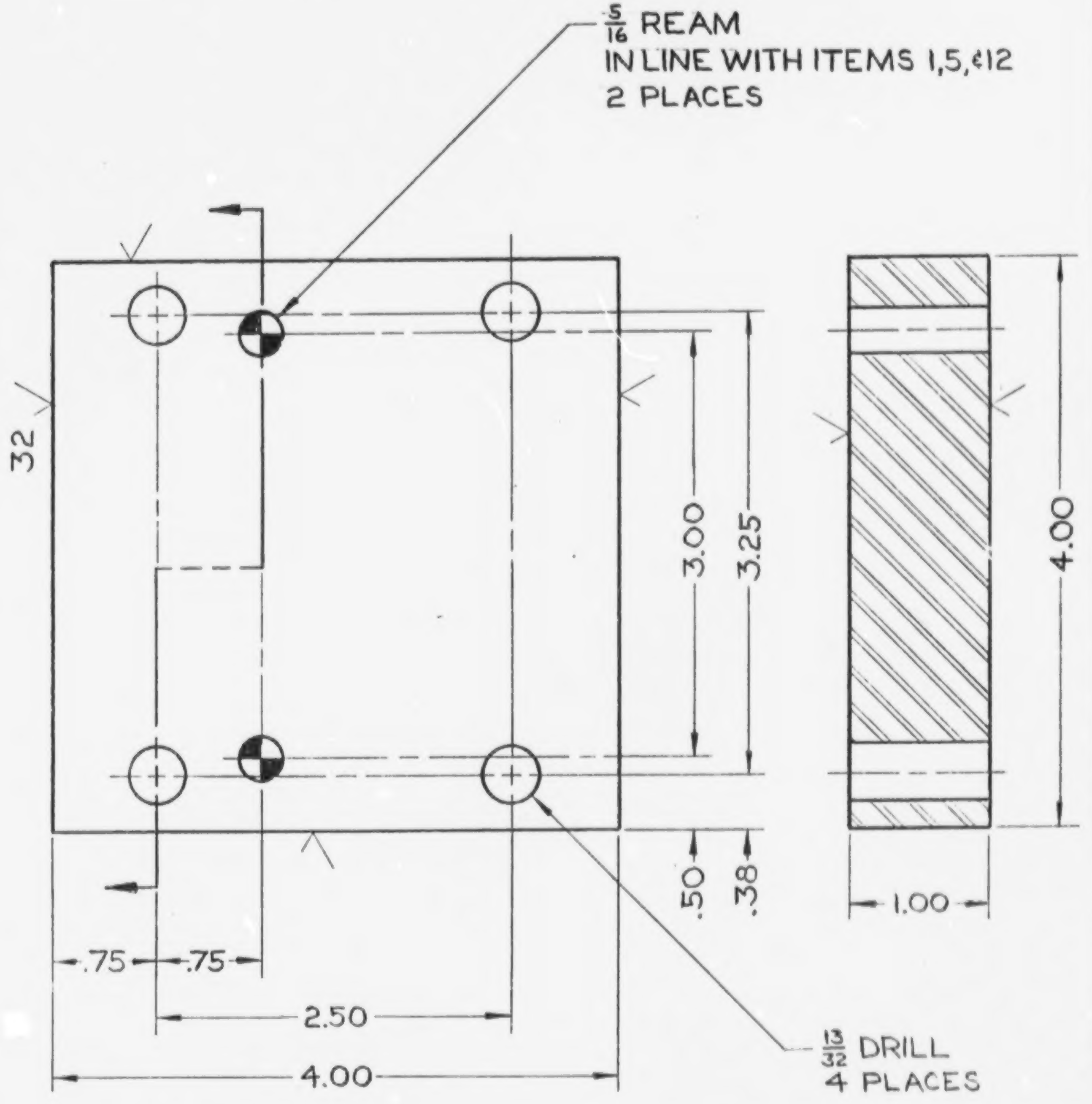
MATL: _____
NO. REQ. _____
DET. NO. _____

TOOL AND DIE MAKING

CHOP-OFF DIE

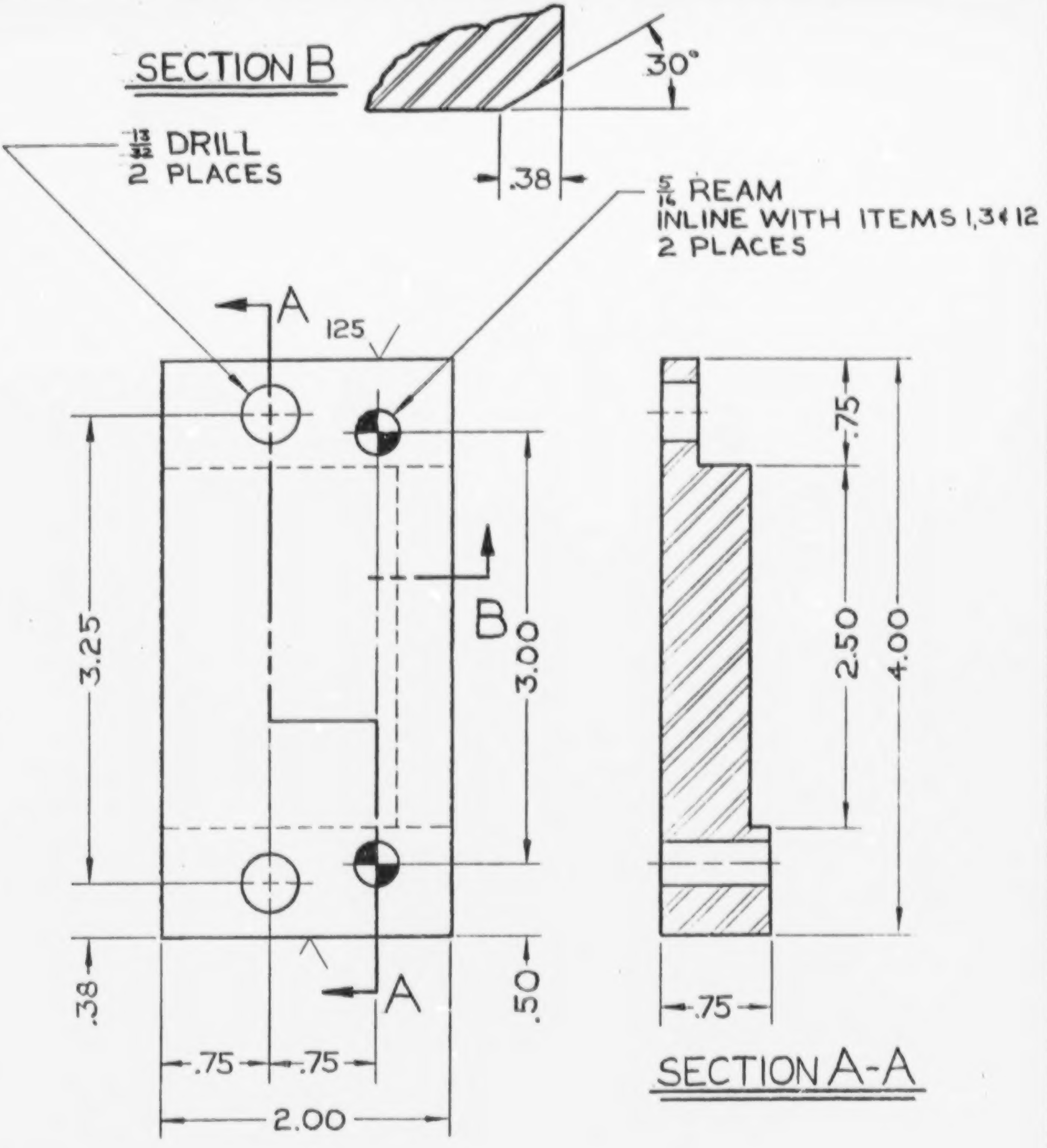
Scale: $\frac{3}{8}$

Sh 2 of 7



5/16 REAM
IN LINE WITH ITEMS 1,5,&12
2 PLACES
32
3.00
3.25
4.00
.50
.38
1.00
.75
.75
2.50
4.00
13/32 DRILL
4 PLACES

ANG ± ___	MATL: ___	TOOL AND DIE MAKING
FRAC ± ___	NO. REQ. 1	DIE BLOCK
XX ± .01	DET. NO. 3	Scale: FULL
XXX ± ___		Sh 3 of 7
XXXX ± ___		


SECTION B
30°
.38
13/32 DRILL
2 PLACES
5/16 REAM
INLINE WITH ITEMS 1,3 & 12
2 PLACES
A
125
B
3.25
3.00
.38
.50
.75
.75
2.00
.75
2.50
4.00
.75
A
SECTION A-A

ANG ±
FRAC ±
XX ± .01
XXX ±
XXXX ±

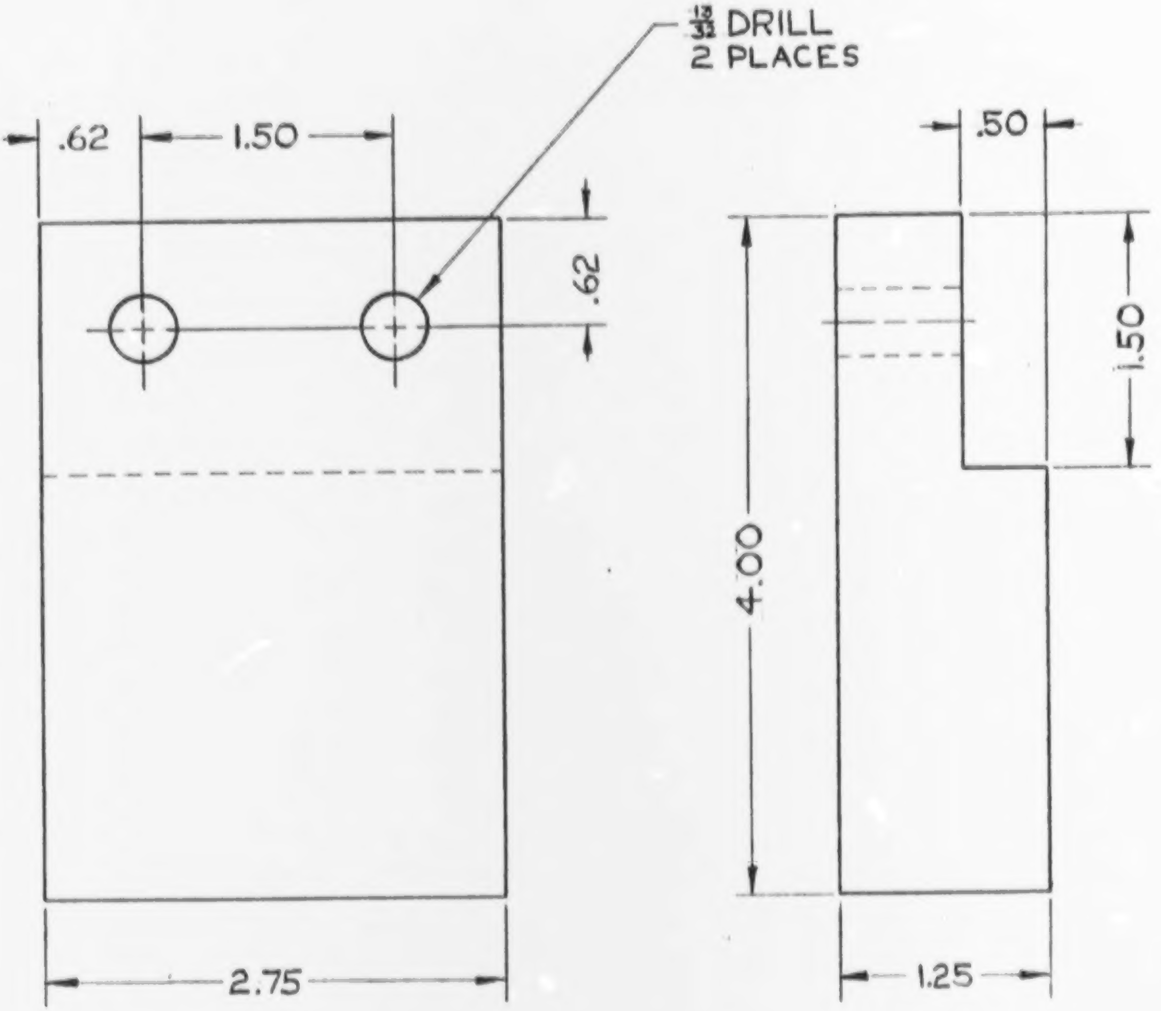
MATL:
NO. REQ. 1
DET. NO. 5

TOOL AND DIE MAKING

STRIPPER

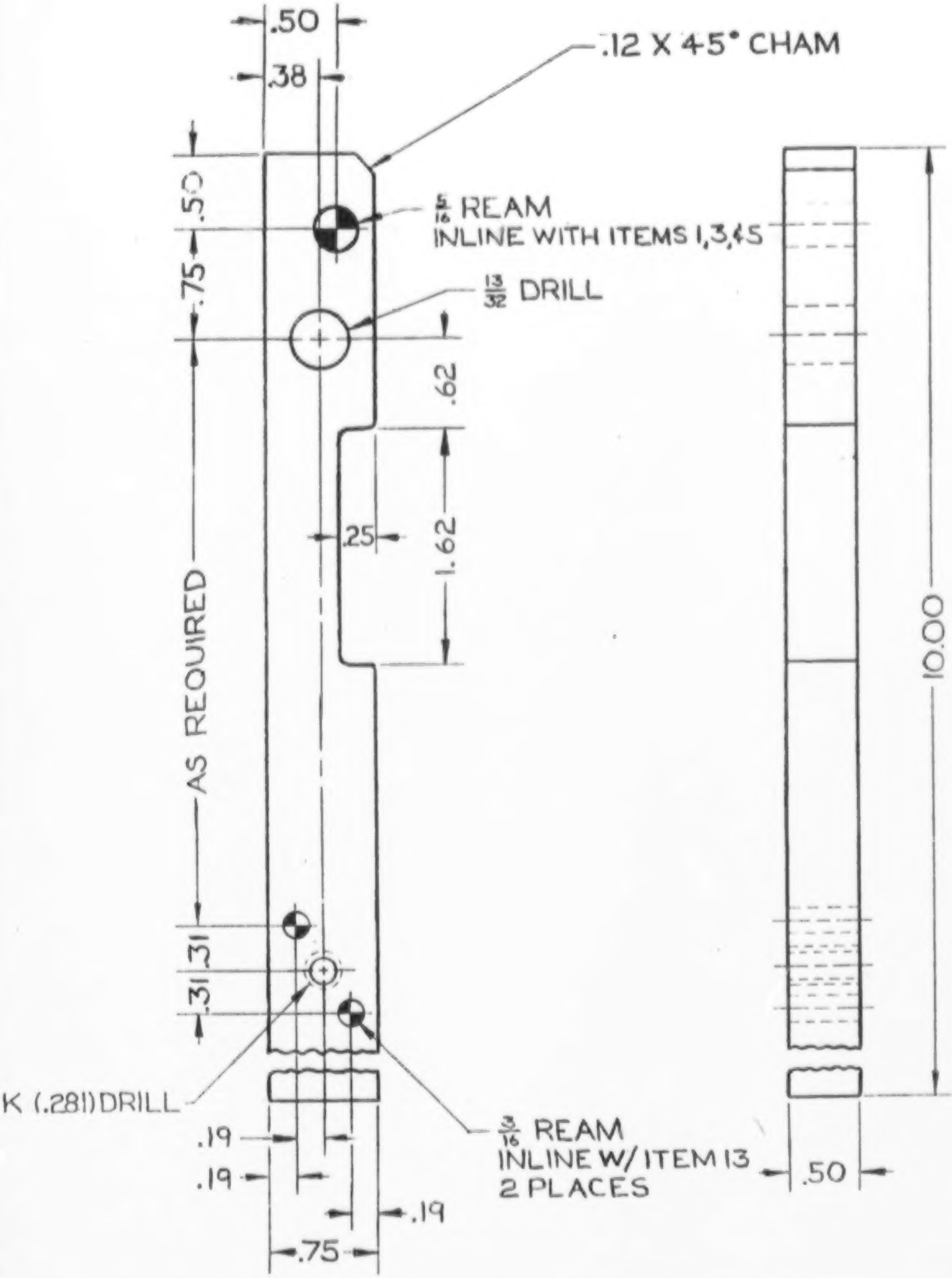
Scale: FULL

Sh 4 of 7

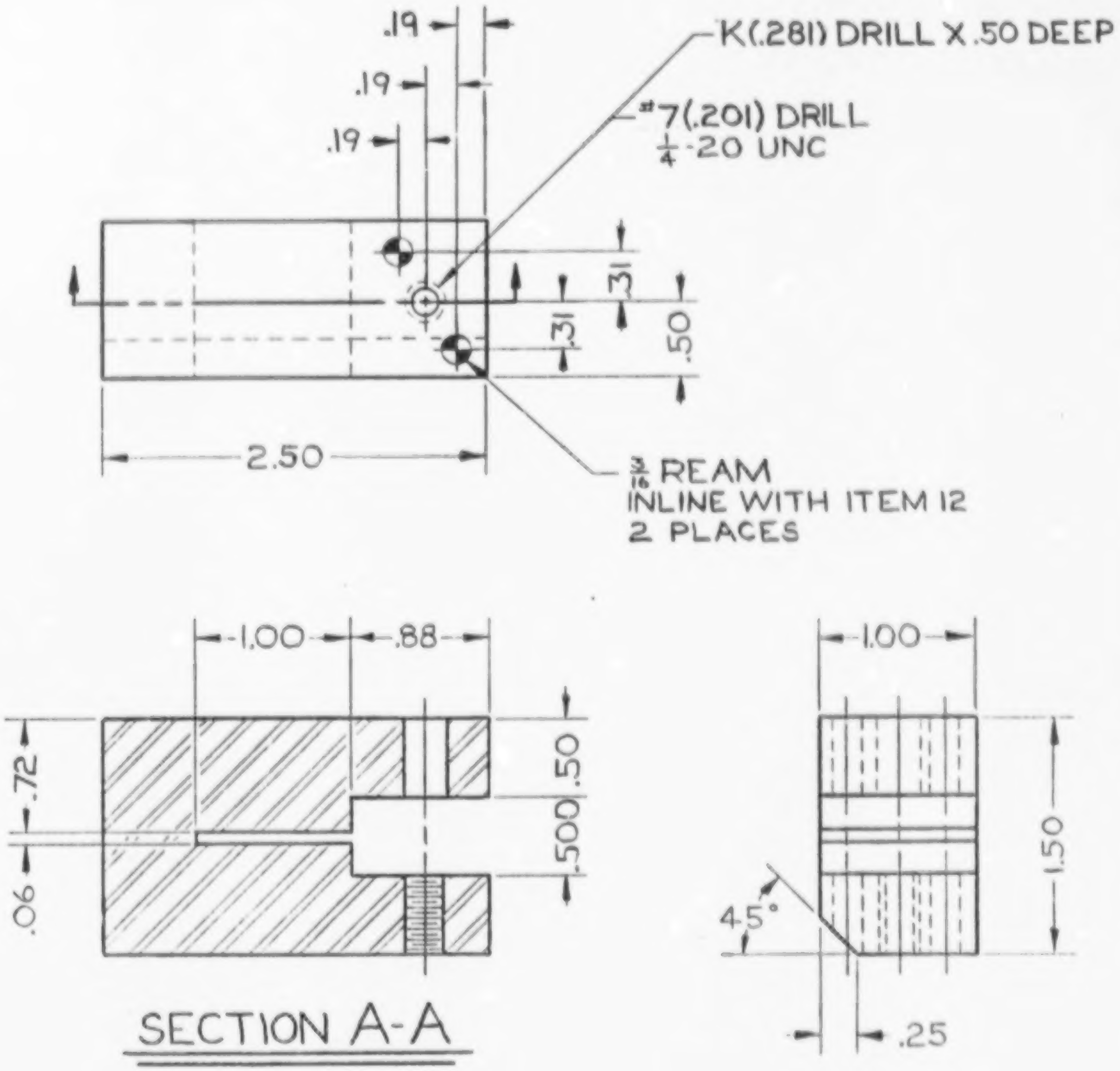


$\frac{13}{32}$ DRILL
2 PLACES
.62
1.50
.62
2.75
.50
1.50
4.00
1.25

ANG ± FRAC ± XX ± .01 XXX ± XXXX ±	MATL: NO. REQ. 1 DET. NO. 10	TOOL AND DIE MAKING PUNCH Scale: FULL Sh 5 of 7


.50
.38
.12 X 45° CHAM
.50
$\frac{5}{16}$ REAM
INLINE WITH ITEMS 1,3,4,5
.75
$\frac{13}{32}$ DRILL
.62
.25
1.62
AS REQUIRED
10.00
.31
.31
K (.281) DRILL
.19
.19
.19
.75
$\frac{3}{16}$ REAM
INLINE W/ ITEM 13
2 PLACES
.50

ANG ± ___ FRAC ± ___ XX ± .01 XXX ± ___ XXXX ± ___	MATL: ___ NO. REQ. 1 DET. NO. 12	TOOL AND DIE MAKING BACK GUAGE Scale: FULL Sh 6 of 7


.19
.19
.19
K(.281) DRILL X .50 DEEP
#7(.201) DRILL
1/4-20 UNC
.31
.31
.50
2.50
3/16 REAM
INLINE WITH ITEM 12
2 PLACES
1.00
.88
.72
.06
.50
.500
1.00
1.50
45°
.25
SECTION A-A

ANG ±
FRAC ±
XX ± .01
XXX ± .002
XXXX ±

MATL:
NO. REQ.
DET. NO. 13

TOOL AND DIE MAKING

STOP

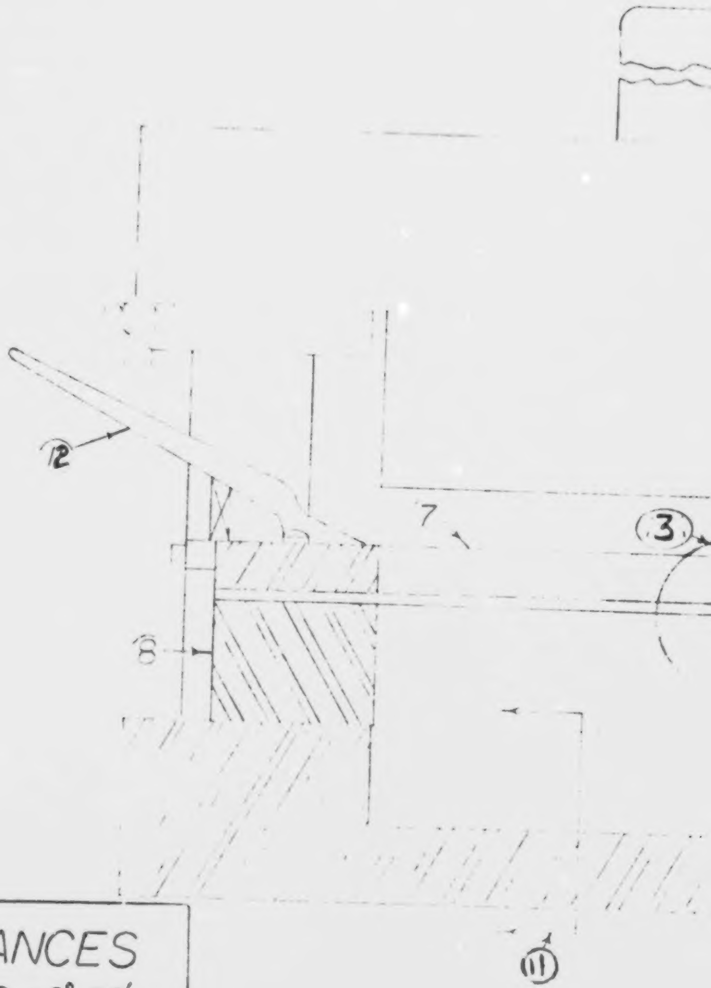
Scale: FULL

Sh 7 of 7

BILL OF MATERIAL

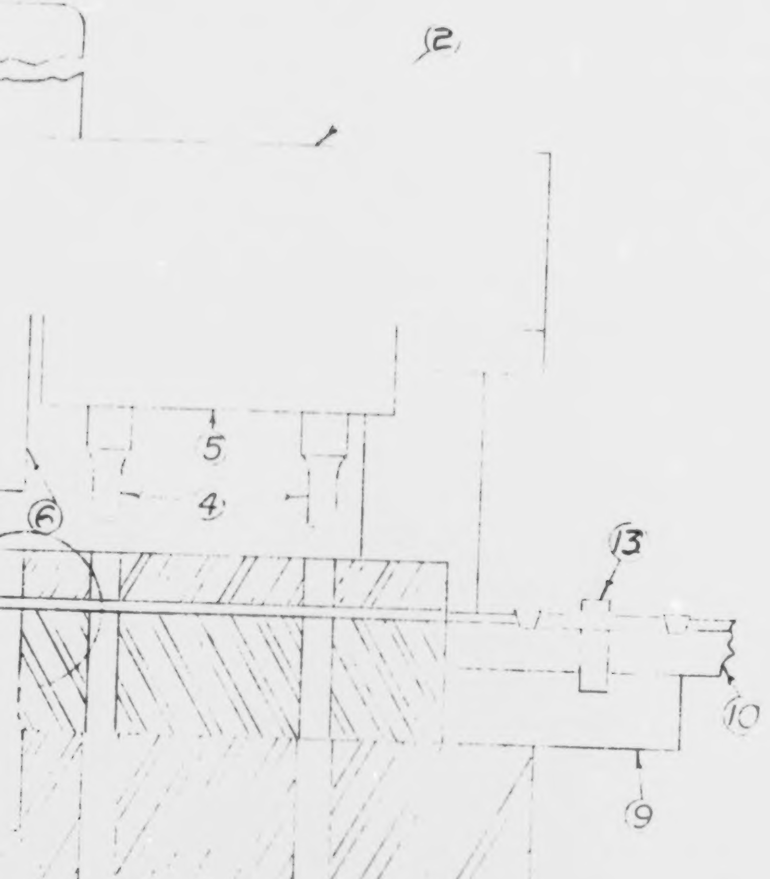
NO.	REQ'D.	PART NAME	MAT'L.	BIN NO.	SPECIFICATIONS
2	1	Assembly drawing			
3	1	Die stop			See instructor
1		Bill of materials			
2		Die set project			Made previously
4	4	Piercing punch	Drill rod		See detail
5	1	Punch plate	CRS	55	"
6	1	Blanking punch	OHTS	48	"
7	1	Stripper	CRS	59	"
8	1	Die	OHTS	60	"
9	1	Stock guide rest	CRS	55	"
10	1	Stock guide	CRS	6	"
12	1	Automatic die gage			See instructor
13	1	Stock pusher			"
11	1	Blank ejection slot			

DET. 1 OF 11

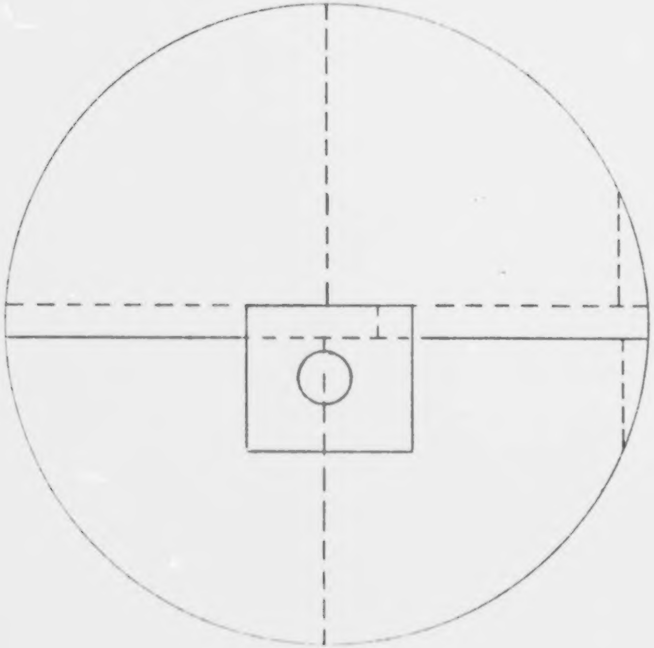


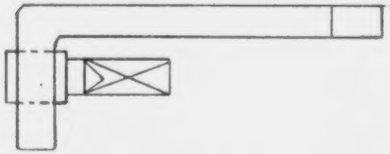
TOLERANCES
ANGULAR ±0° 30′
FRAC. ±1/64
XXX ±.005
XXXX ±.0005

COURSE	SCALE
TOOL + DIE	$\frac{3}{4}=1$

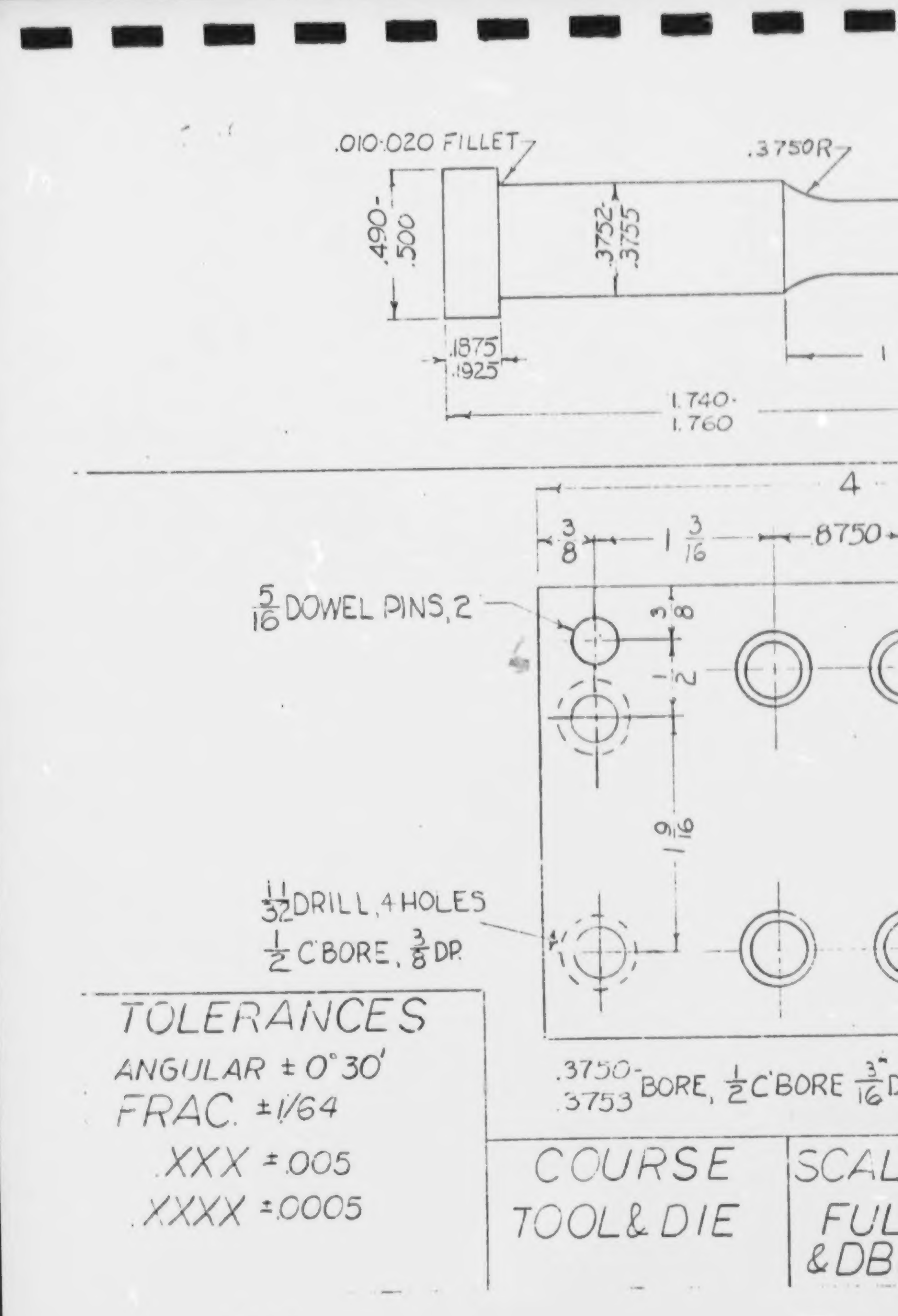


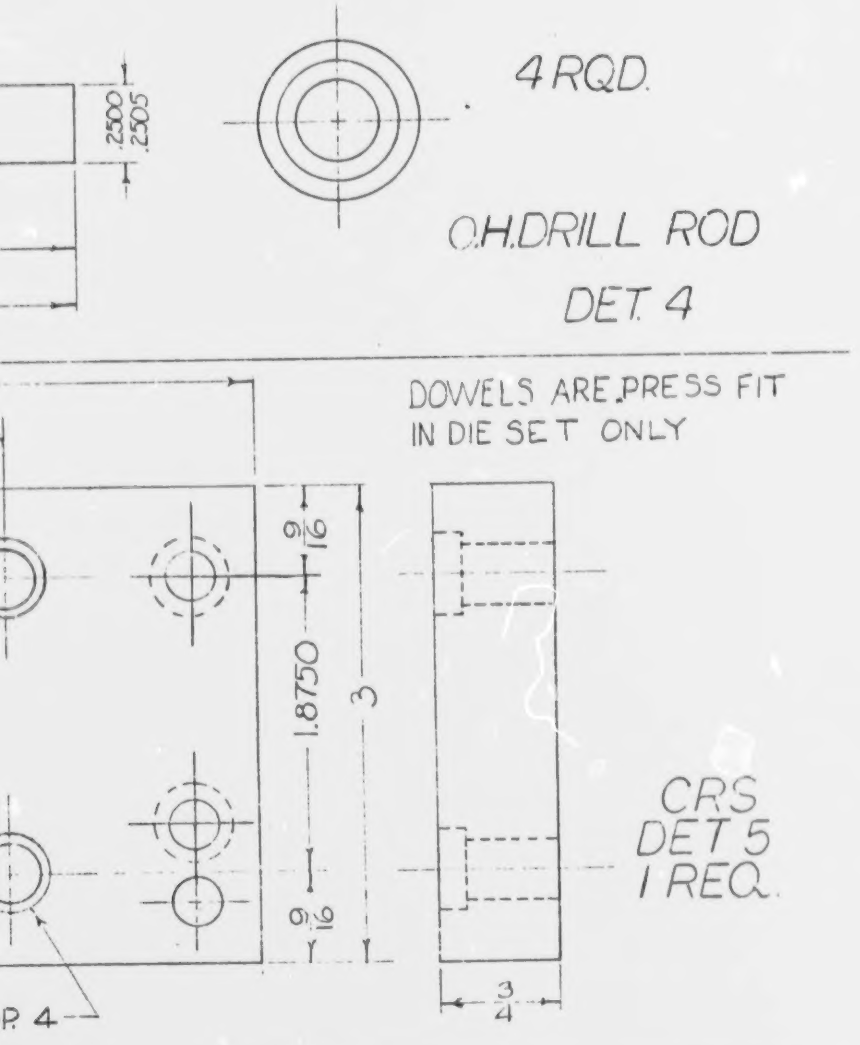
MAT'L.	PROGRESSIVE	DET.
REQ. 1	DIE	2 OF 11



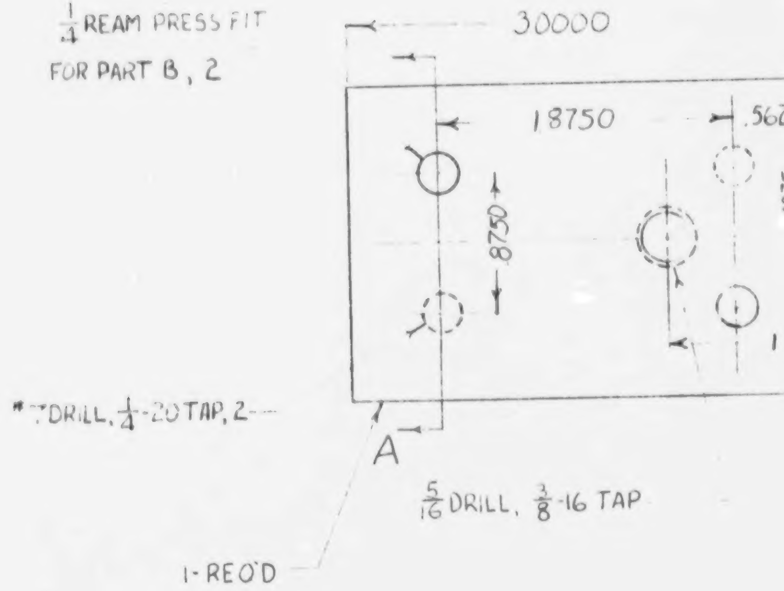


DET. 3 OF 11


.010-.020 FILLET
.3750R
.490-.500
.3752-.3755
.1875
.1925
1.740-
1.760
1
4
3/8
1 3/16
.8750
5/16 DOWEL PINS, 2
3/8
1/2
1 9/16
11/32 DRILL, 4 HOLES
1/2 C'BORE, 3/8 DP.
.3750-
.3753 BORE, 1/2 C'BORE 3/16" D
TOLERANCES
ANGULAR ± 0° 30'
FRAC. ±1/64
.XXX ±.005
.XXXX ±.0005
COURSE
TOOL & DIE
SCAL
FUL
& DB


.2500
.2505
4 RQD.
O.H. DRILL ROD
DET. 4
DOWELS ARE PRESS FIT
IN DIE SET ONLY
9/16
1.8750
3
9/16
P. 4
3/4
CRS
DET 5
1 REQ.

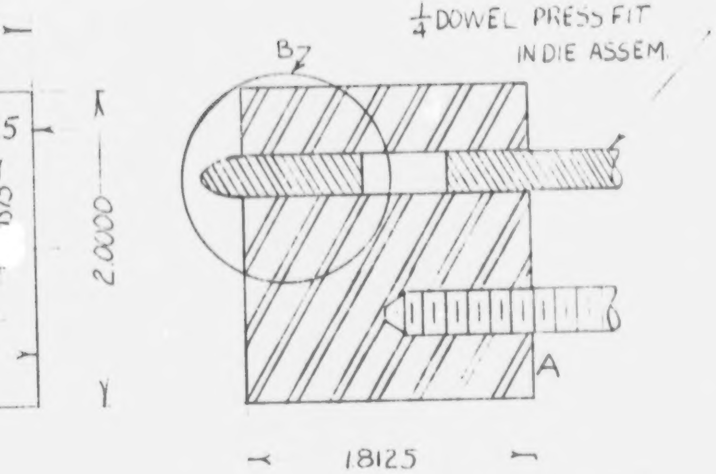
E	MAT'L. NOTE	PUNCH &	DET.
L	NO. REQ. NOTE	PUNCH PLATE	4 & 5 OF 11

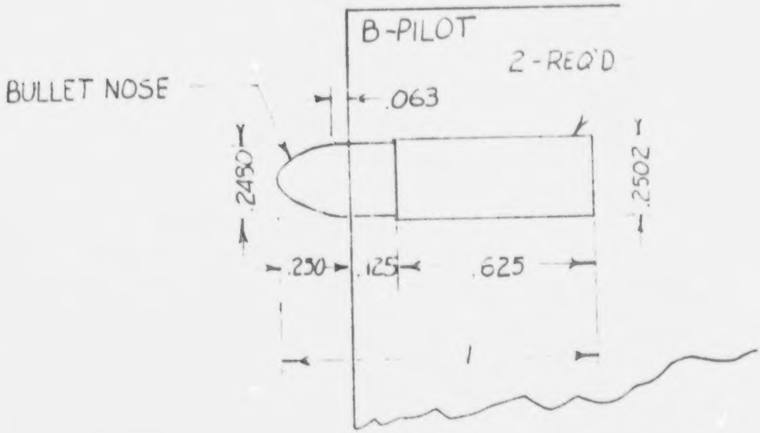

1/4 REAM PRESS FIT
FOR PART B, 2
30000
18750
.562
8750
1
* 7 DRILL, 1/4-20 TAP, 2
A
5/16 DRILL, 3/8-16 TAP
1-REQ'D

TOLERANCES
ANGULAR ±0° 30'
FRAC. ±1/64
XXX ±.005
XXXX ±.0005

COURSE
TOOL DIE

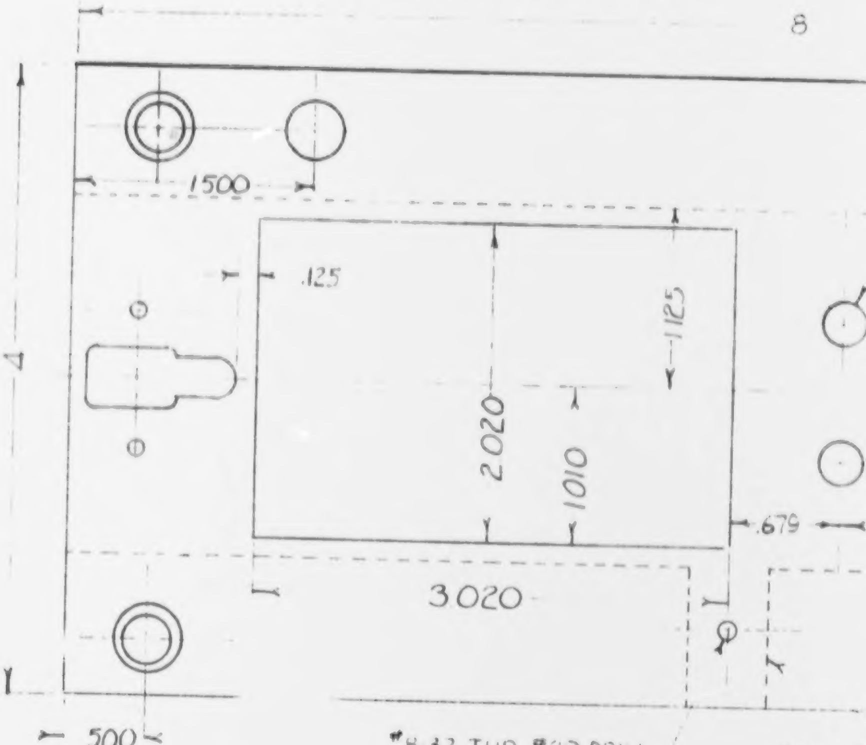
SCA
FU


5
2.0000
B
$\frac{1}{4}$ DOWEL PRESS FIT
IN DIE ASSEM.
A
1.8125


B-PILOT
2-REQ'D
BULLET NOSE
.063
.2490
.2502
.250
.125
.625
1

LE	MATL OH TS	BLANKING	DET
LL	NO REQ NOTE	PUNCH	6 OF 11

DOWELS ARE PRESS FIT IN DIE AND
LOOSE FIT IN STRIPPER & DIE ASSEM.


270L
8
1500
.125
1125
2020
1010
.679
3020
.500

#8-32 THR #29 DRILL

SEE DET

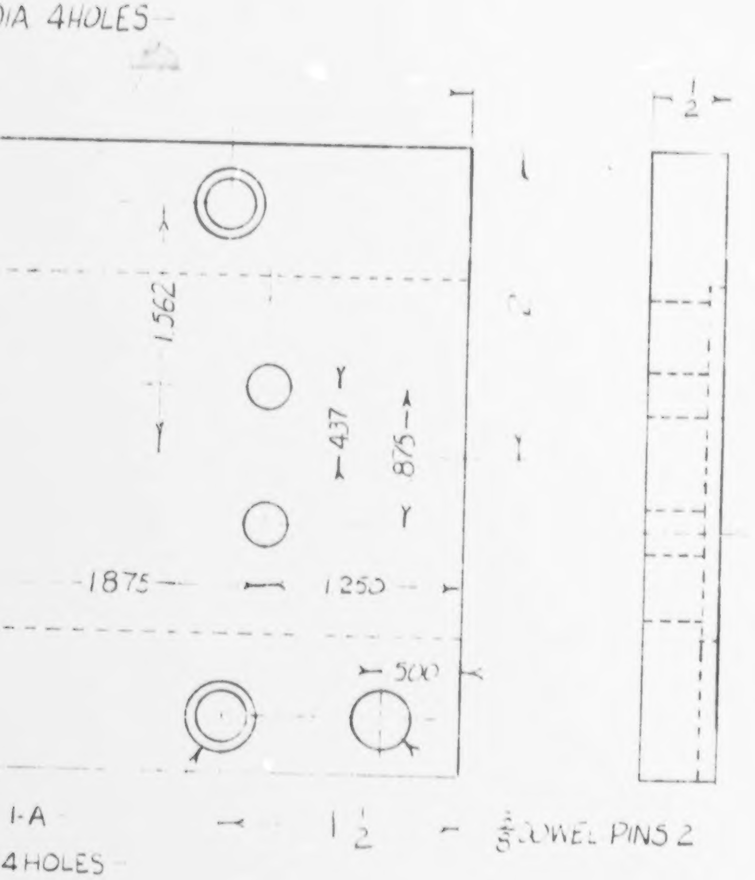
$\frac{5}{16}$ DRILL, $\frac{1}{2}$ C'BORE $\frac{5}{16}$ DP

TOLERANCES
ANGULAR ±0° 30'
FRAC ±1/64
XXX ±.005
X/XX ±.0005

COURSE
TOOL & DIE

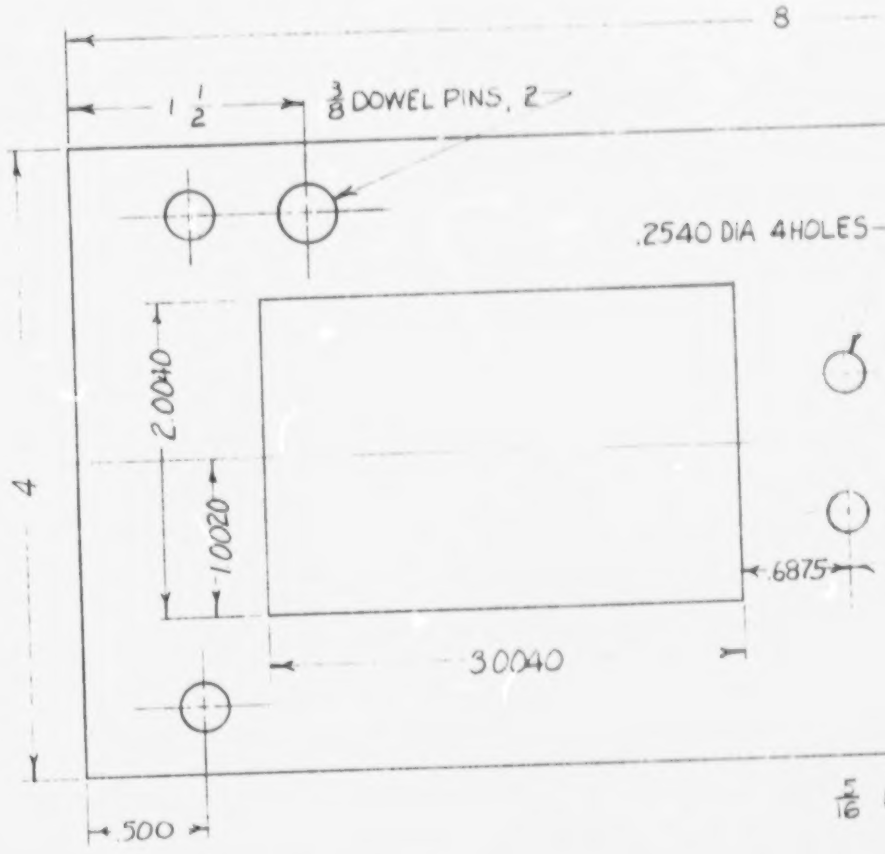
SCALE
FULL

BEST COP


DIA 4HOLES
1/2
1.562
.437
.875
1.875
1.250
.500
1-A
1 1/2
3/8 DOWEL PINS 2
4 HOLES

MATL CRS NO. REQ. 1	STRIPPER PLATE	DET 7 OF 11

Y AVAILABLE

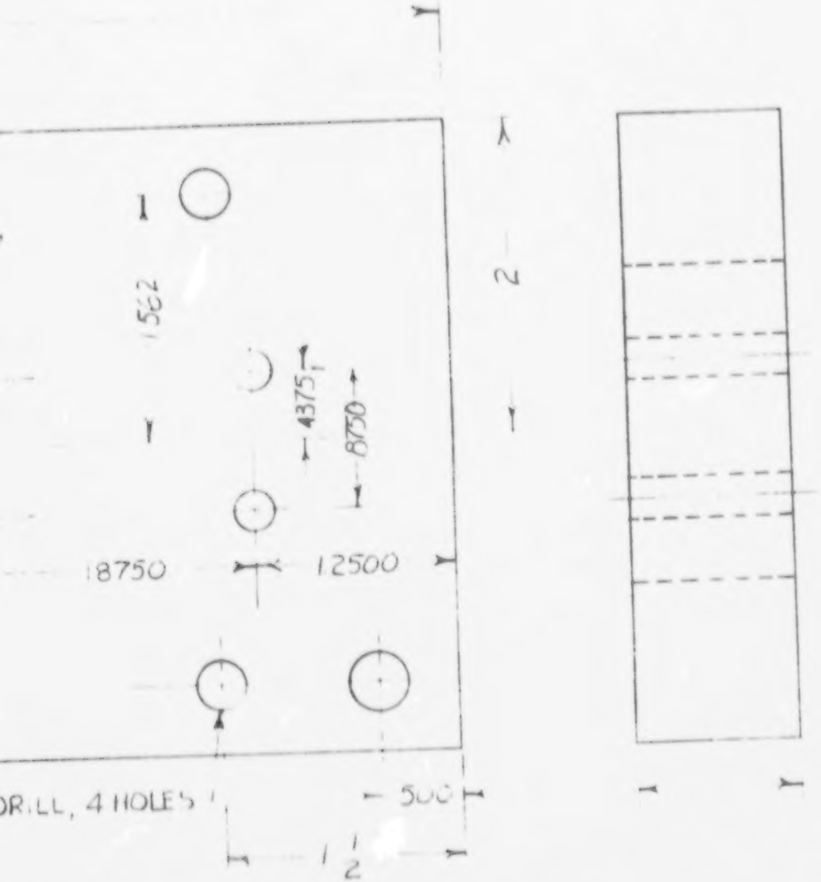

8
1 1/2
3/8 DOWEL PINS, 2
.2540 DIA 4HOLES
2.0040
1.0020
4
.6875
3.0040
5/16
.500

DOWELS ARE PRESS FIT IN
LOOSE FIT IN STRIPPER AN

TOLERANCES
ANGULAR ±0° 30'
FRAC. ±1/64
.XXX ±.005
.XXXX ±.0005

COURSE
TOOL & DIE

SCAL
FUL

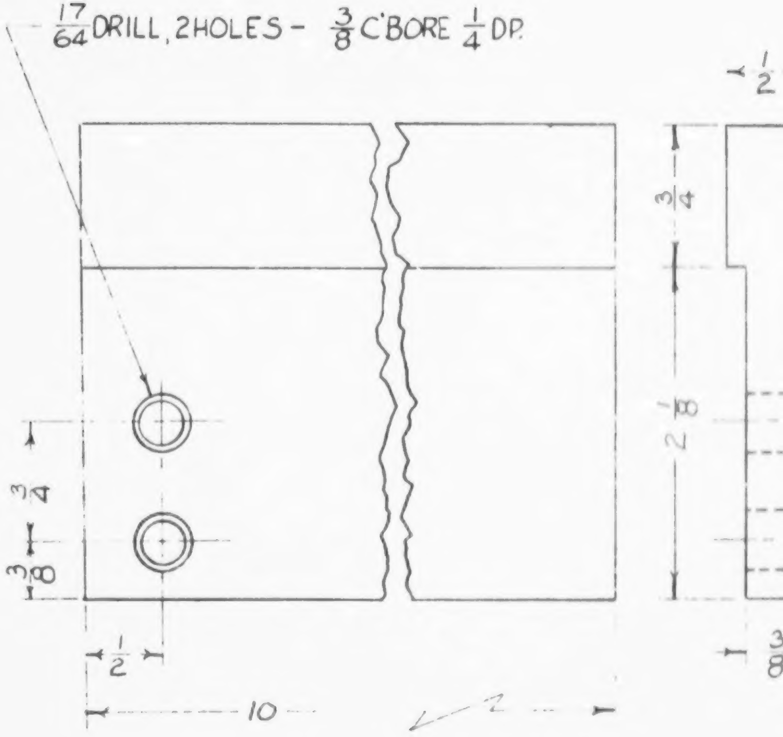


1562
.4375
.8750
2
.18750
1.2500
.500
1 1/2
DRILL, 4 HOLES

DIE AND
D DIE ASSEM.

E | MAT'L. CHTS.
L | NO. REQ. 1

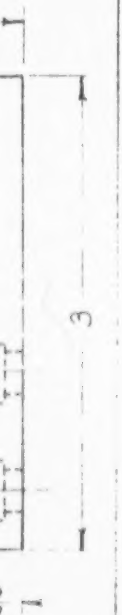
DIE

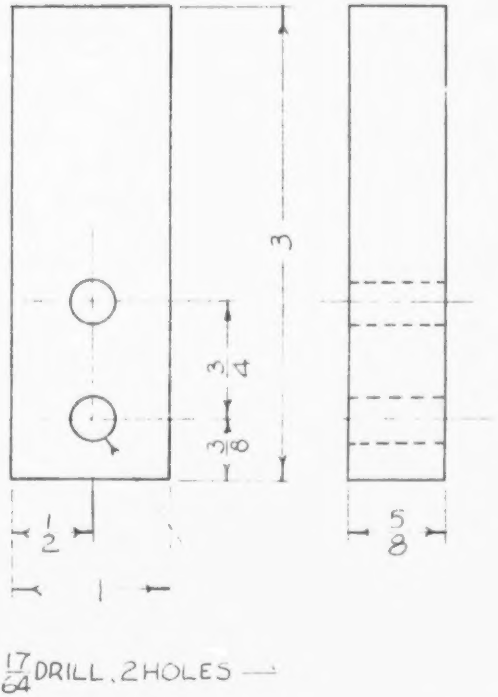

17/64 DRILL, 2 HOLES - 3/8 C'BORE 1/4 DP.
1/2
3/4
2 1/8
3/4
3/8
1/2
10
2
3/8

TOLERANCES
ANGULAR ± 0° 30'
FRAC. ± 1/64
XXX ± .005
XXXX ± .0005

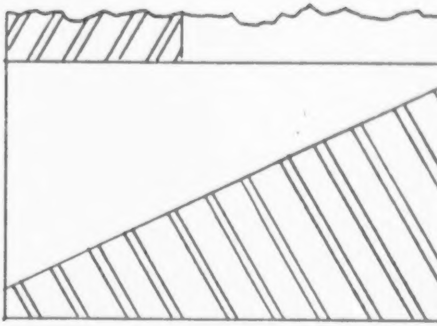
COURSE
TOOL&DIE

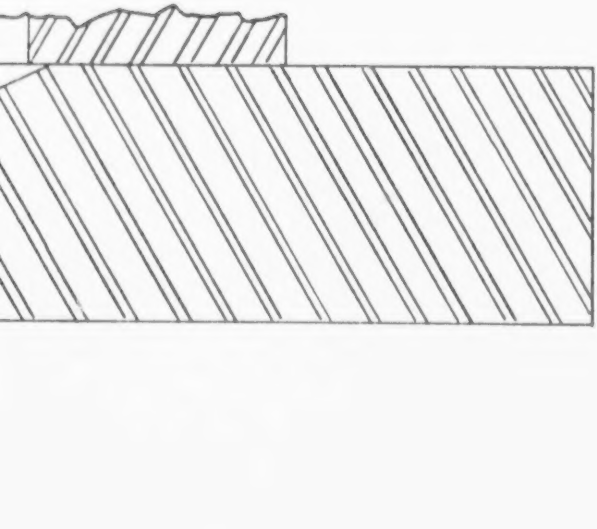
SCAL
FUL




3
3/4
3/8
1/2
1
5/8
17/64 DRILL, 2 HOLES

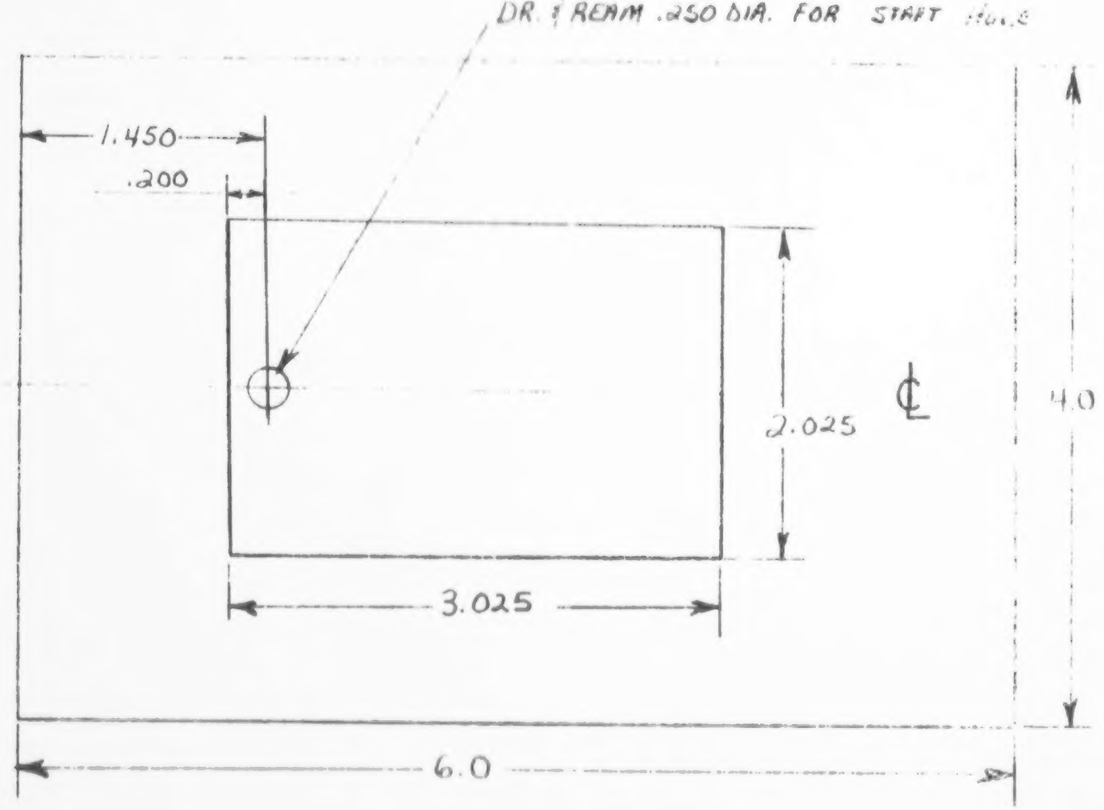
LE	MAT'L. CRS	STOCK GUIDE	DET.
L	NO. REQ. 1 EA	AND REST	9,10 & 11





DE T. 11OF11

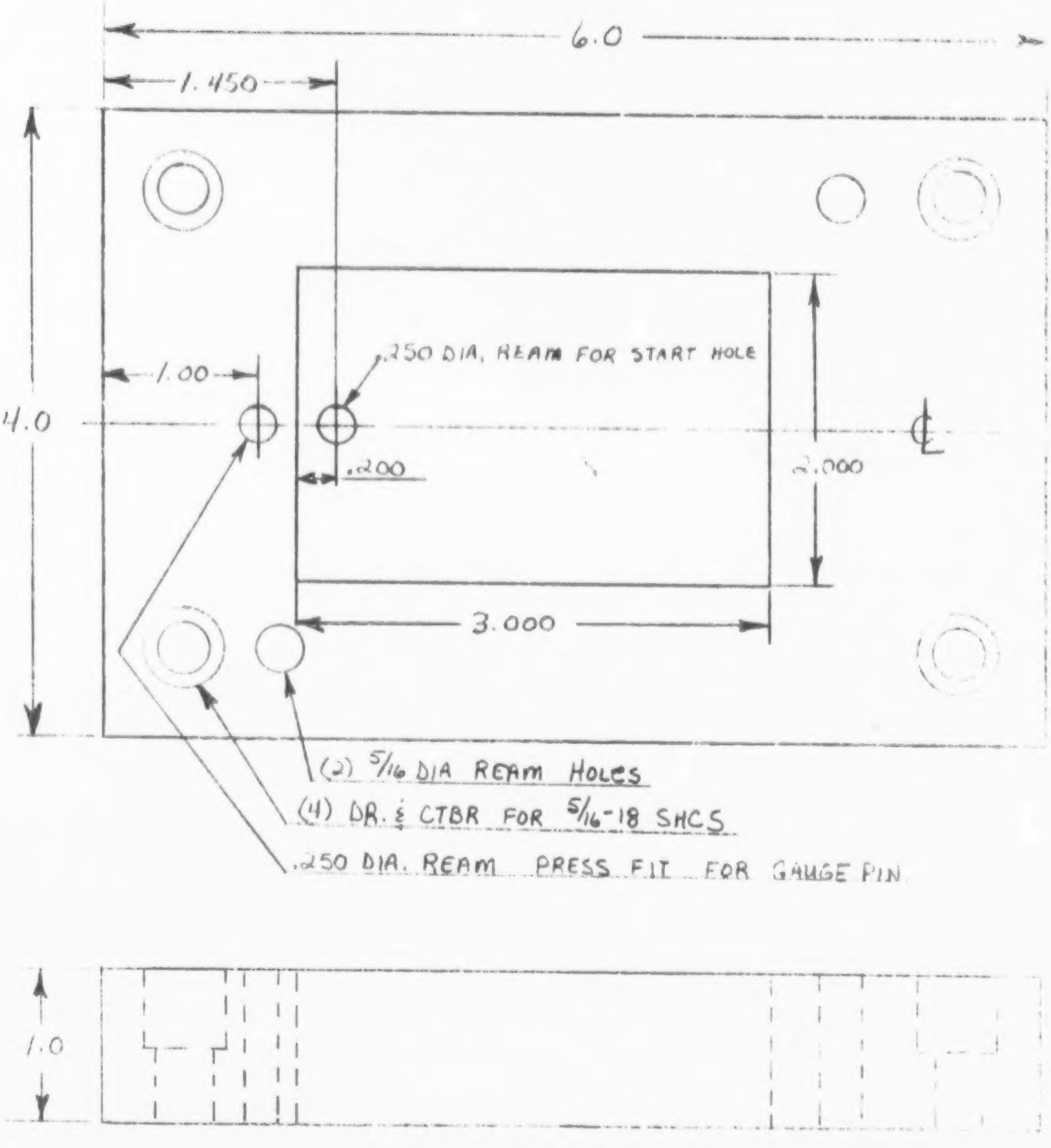
STRIPPER
1/2" X 4 X 6 CRS



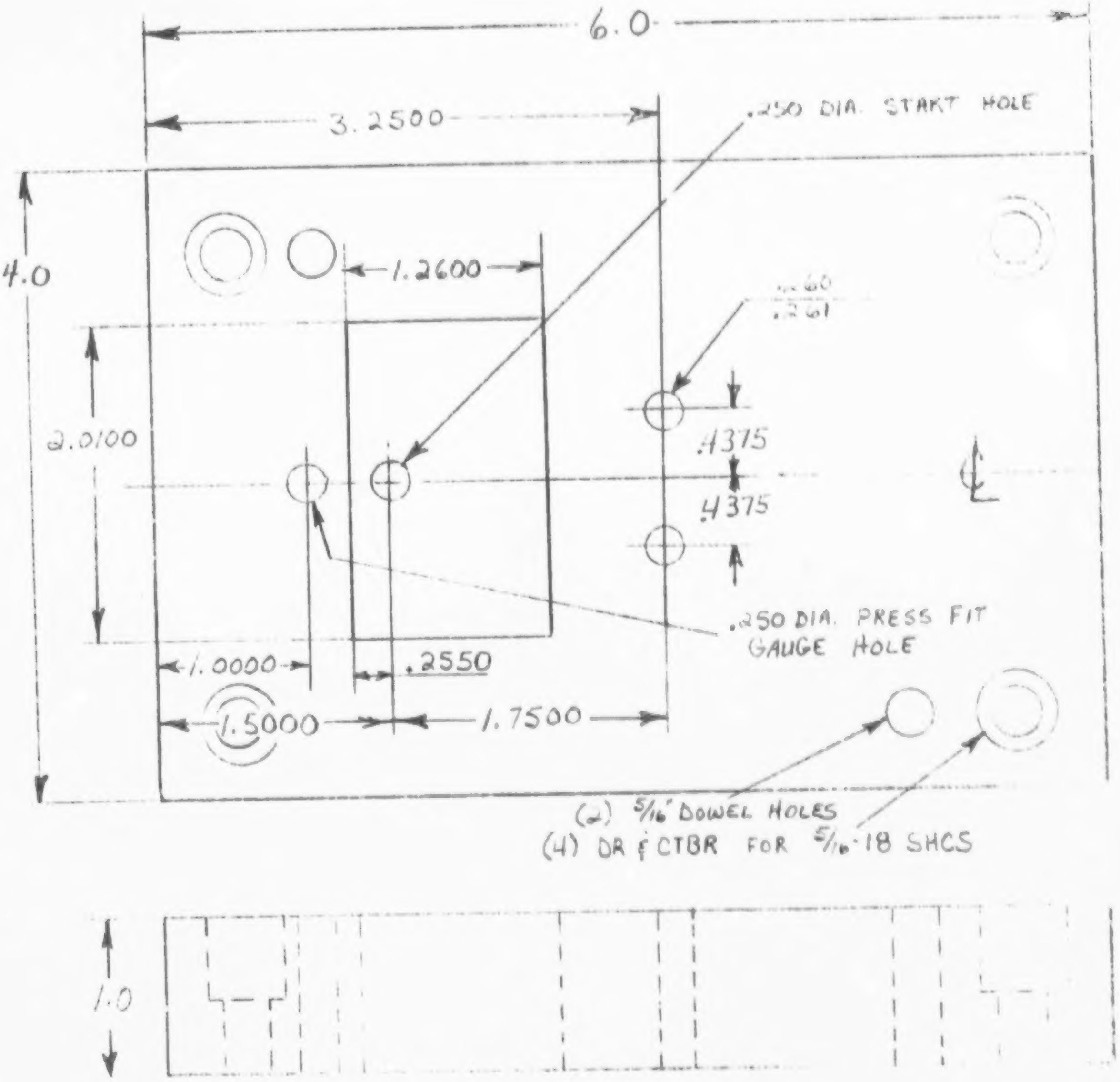
DR. & REAM .250 DIA. FOR START HOLE

1.450
.200
2.025
℄
4.0
3.025
6.0

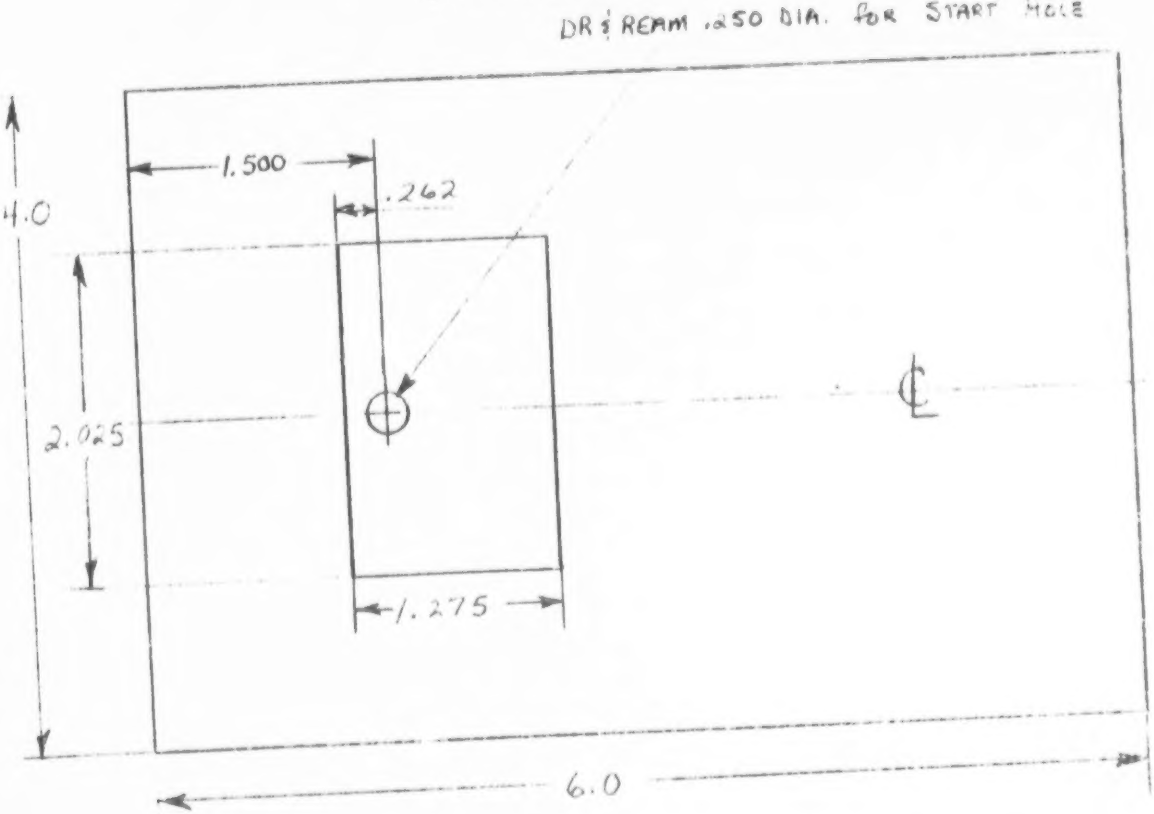
X DIE BLOCK
1" X 4" X 6" O-1 TOOL STEEL


6.0
1.450
.250 DIA, REAM FOR START HOLE
1.00
4.0
.200
2.000
3.000
(2) 5/16 DIA REAM HOLES
(4) DR. & CTBR FOR 5/16-18 SHCS
.250 DIA. REAM PRESS FIT FOR GAUGE PIN
1.0

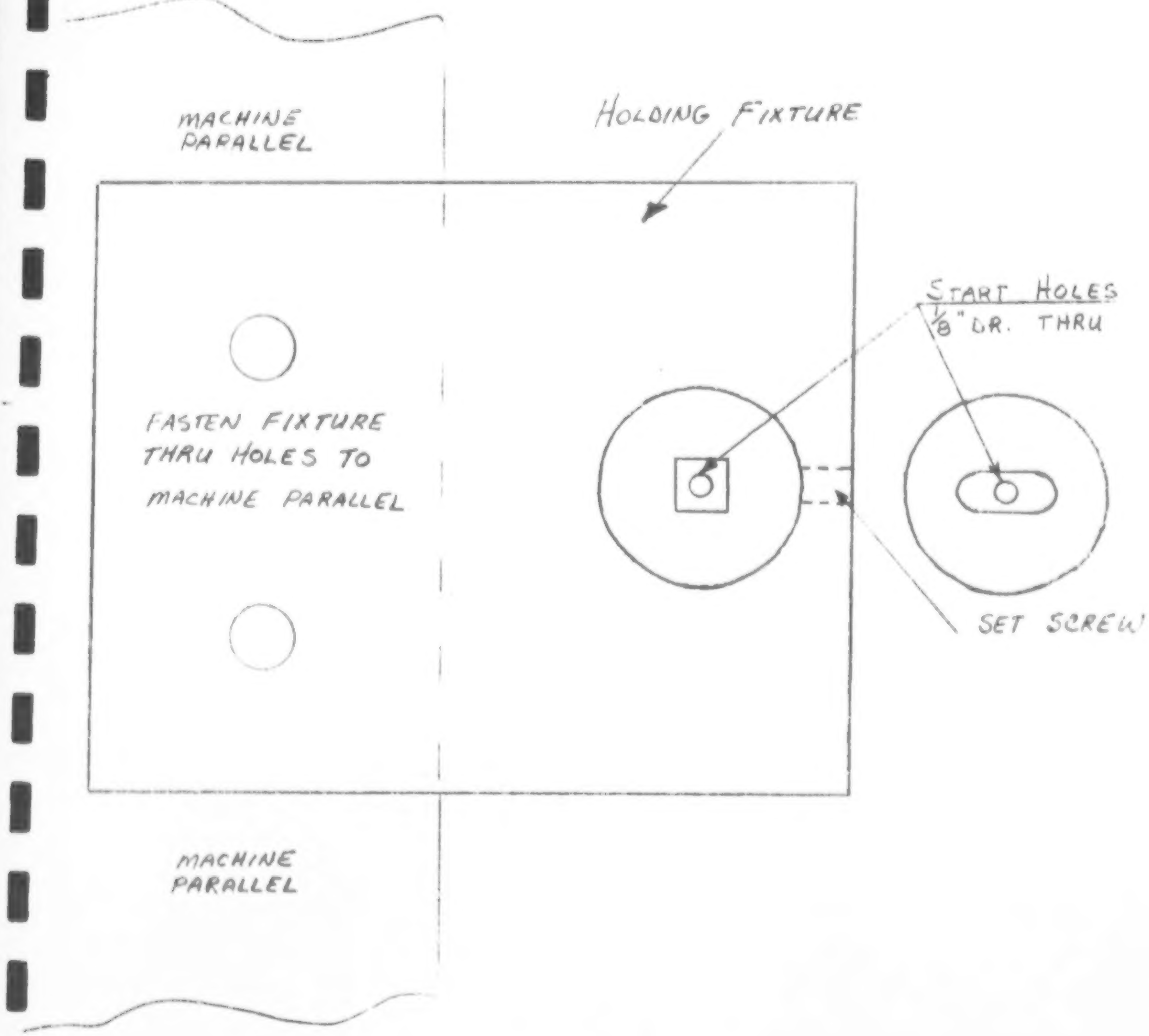
1.2600 X 2.0100 DIE BLOCK
1"X4X6 O-1 TOOL STEEL


6.0
3.2500
.250 DIA. START HOLE
4.0
1.2600
.260
.261
2.0100
.4375
.4375
℄
.250 DIA. PRESS FIT
GAUGE HOLE
1.0000
.2550
1.5000
1.7500
(2) 5/16" DOWEL HOLES
(4) DR & CTBR FOR 5/16-18 SHCS
1.0

STRIPPER
½" X4 X6 CRS


DR & REAM .250 DIA. FOR START HOLE
1.500
.262
4.0
2.025
1.275
6.0
℄

.262 SQ. & .198 X.510 OBLONG BUSHINGS


MACHINE PARALLEL
HOLDING FIXTURE
START HOLES
1/8" DR. THRU
FASTEN FIXTURE THRU HOLES TO MACHINE PARALLEL
SET SCREW
MACHINE PARALLEL